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northeastern university bulletin

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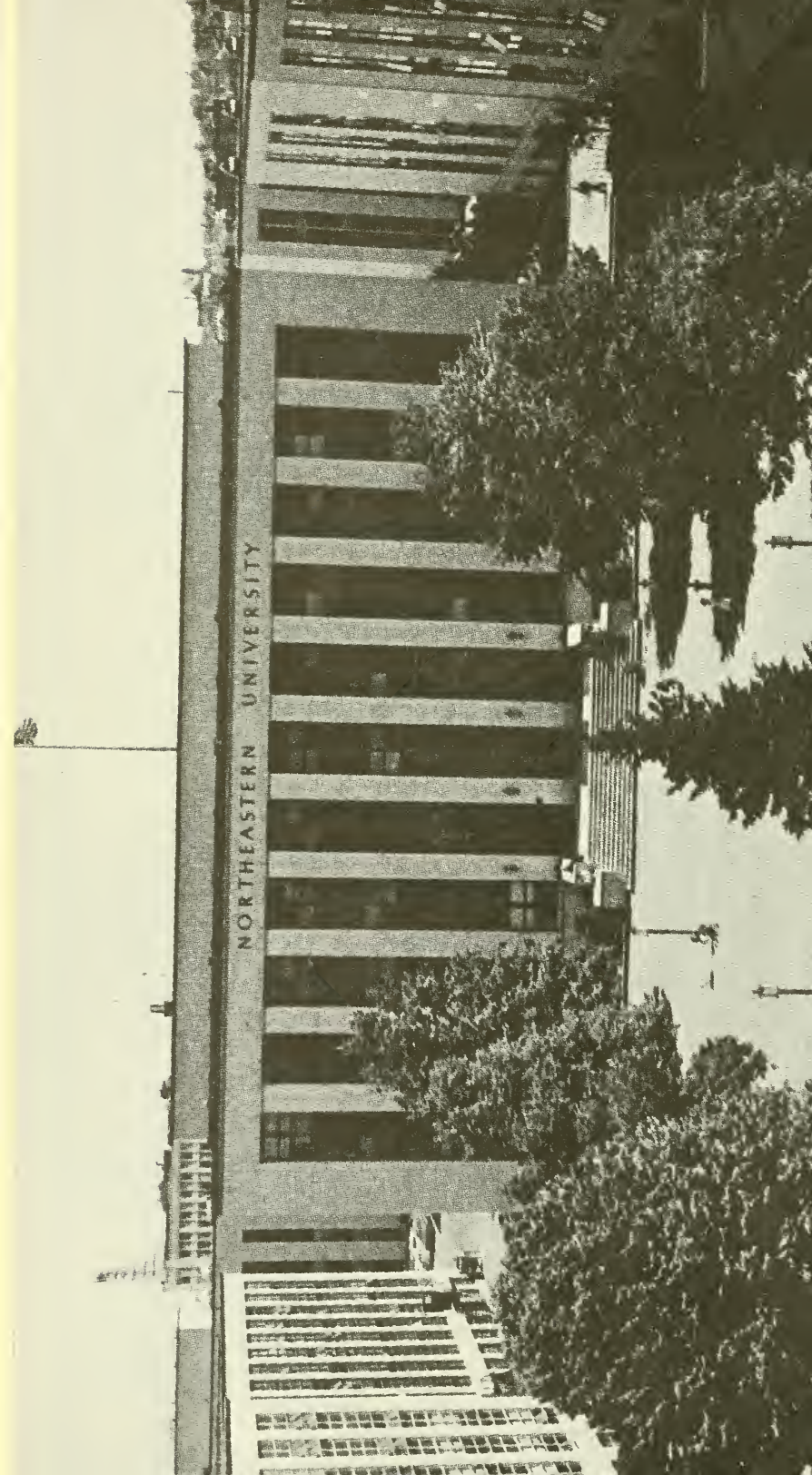


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Northeastern University
224 Hayden Hall
360 Huntington Avenue
Boston, Massachusetts 02115
Telephone (617) 437-2714

Graduate School of Business Administration 1974-75
Accredited by the American Assembly of Collegiate Schools of Business.

NORTHEASTERN UNIVERSITY



contents

4	Academic Calendar
5	University Holidays
7	The Governing Boards and Officers of the University
19	The University, Graduate Level Programs, and Research Activities
22	Buildings and Facilities
22	Main Campus Facilities
23	Suburban Facilities
25	The Graduate School of Business Administration
25	Full-Time Internship
26	Full-Time Non-internship
26	Full-Time Assistantship
27	Part-Time Study
28	General Regulations
33	Financial Information
37	The Faculty
41	Master of Business Administration Curriculum
47	Description of Courses
61	Undergraduate Universities Attended by Students
62	Faculty Office and Telephone Directory
63	Index
64	Campus Map

ACADEMIC CALENDAR 1974-1975

Fall Quarter 1974

Registration period (1:00-3:00 and 5:30-8:00 p.m.)		
Burlington	Tuesday-Wednesday	Sept. 17-18
Boston	Monday-Thursday	Sept. 23-26
Interview period for new students by appointment*		
	Tuesday-Thursday	Sept. 17-26
Classes begin	Monday	September 30
Last day to drop a course	Wednesday	November 27
Examination period	Monday-Saturday	Dec. 16-21

Winter Quarter 1974-1975

Registration period (1:00-3:00 and 5:30-8:00 p.m.)		
Burlington	Tuesday	Dec. 3
Boston	Monday-Thursday	Dec. 9-12
Interview period for new students by appointment*		
	Monday-Thursday	Dec. 9-12
Classes begin	Monday	January 6
Last day to drop a course	Saturday	March 8
Examination period	Monday-Saturday	Mar. 24-29

Spring Quarter 1975

Registration period (1:00-3:00 and 5:30-8:00 p.m.)		
Burlington	Tuesday	March 11
Boston	Monday-Thursday	Mar. 17-20
Classes begin	Monday	April 7
Last day to file commencement card for June commencement		
	Tuesday	April 1
Last day to pay fee for June commencement		
	Wednesday	April 30
Last day to drop a course	Saturday	June 7
Final grades due in Registrar's Office for June graduates taking third quarter course		
	Friday	June 6
Examination period	Monday-Saturday	June 16-21
Spring commencement	Sunday	June 22

Examinations for day classes will be held in accordance with the undergraduate examination schedule.

*Appointments for interviews with new students must be made at least four days before the date of the interview.

UNIVERSITY HOLIDAYS 1974-1975

Columbus Day	Monday	October 14
Veterans' Day	Monday	October 28
Thanksgiving Recess	Thursday-Saturday	Nov. 28-Nov. 30
Christmas Vacation	Monday-Saturday	Dec. 23-Jan. 4
Washington's Birthday	Monday	February 17
Patriots' Day	Monday	April 21
Memorial Day	Monday	May 26
Independence Day	Friday	July 4
Labor Day	Monday	September 1

Equal Opportunity Policy

Northeastern University is committed to a policy of providing equal opportunity for all. In all matters involving admission, registration, and all official relationships with students, including evaluation of academic performance, the University insists on a policy of nondiscrimination. Northeastern University is also an equal opportunity employer; it is institutional policy that there shall not be any discrimination against any employee or applicant for employment because of race, color, religion, sex, age or national origin. In addition, Northeastern takes affirmative action in the recruitment of students and employees.



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the university

Founded in 1898, Northeastern University is incorporated as a privately endowed nonsectarian institution of higher learning under the General Laws of Massachusetts. The State Legislature by special enactment has given the University general degree-granting powers. The University is governed by a Board of Trustees elected by and from the Northeastern University Corporation, which is composed of nearly 180 distinguished business and professional men and women.

From its beginning, Northeastern University has had as its dominant purpose the discovery of community educational needs and the meeting of these in distinctive and serviceable ways. The University has not duplicated the programs of other institutions, but has sought to pioneer new areas of educational service.

A distinctive feature of Northeastern University is its Cooperative Plan, initiated by the College of Engineering in 1909 and subsequently adopted by the Colleges of Business Administration (1922), Liberal Arts (1935), Education (1953), Pharmacy (1962), Nursing (1964), Boston-Bouv  College (1964); the College of Criminal Justice (1967); and by Lincoln College's daytime Bachelor of Engineering Technology program (1971). This educational method enables students to gain valuable practical experience as an integral part of their college program and also provides the means by which they may contribute substantially to the financing of their education. The Plan has been extended to the graduate level in engineering, actuarial science, rehabilitation administration, professional accounting, business administration, and law.

In the field of adult education, programs of study have been developed to meet a variety of needs. University College offers evening courses — offered by the University since 1906 — and adult-day courses leading to the bachelor's degree. In addition to offering day undergraduate programs in Electrical Engineering Technology and Mechanical Engineering Technology, Lincoln College offers evening/part-time certificate, associate, and bachelor degree programs in technological areas. All formal courses of study leading to degrees through part-time programs are approved by the Basic College faculties concerned.

GRADUATE AND PROFESSIONAL SCHOOLS

The ten graduate and professional schools of the University offer day and evening programs leading to the degrees listed.

The Graduate School of Actuarial Science offers the degree of Master of Science in Actuarial Science.

The Graduate School of Arts and Sciences offers the degrees of Master of Arts, Master of Science, Master of Science in Health Science, Master of Public Administration, and Doctor of Philosophy.

The Graduate School of Boston-Bouv  College offers the degree of Master of Science, with specialization in Physical Education or Recreation Education.

The Graduate School of Business Administration offers the degree of Master of Business Administration.

The Graduate Program in Criminal Justice offers the degree of Master of Science.

The Graduate School of Education offers the degree of Master of Education and the Certificate of Advanced Graduate Study.

The Graduate School of Engineering offers the degrees of Master of Science, Engineer degree, Doctor of Engineering, and Doctor of Philosophy.

The School of Law offers the degree of Juris Doctor.

The Graduate School of Pharmacy and Allied Health Professions offers the degrees of Master of Science and Doctor of Philosophy.

The Graduate School of Professional Accounting offers the degree of Master of Science in Accounting.

CENTER FOR CONTINUING EDUCATION

The Center for Continuing Education was established in 1960 to relate the University to the needs of its community in a period of accelerated change. Adult education programs offered by the Center and University College have since been consolidated. Its programs are composed of seminars, conferences, institutes, forums, and a wide variety of special courses designed to serve specific needs. The Division of Special Programs, working cooperatively with trade associations and professional societies, offers a wide variety of programs dealing with current needs and problems. Through its Division of Community Services, working with governmental agencies and community organizations, the Center is becoming increasingly involved in social problems on both the local and national level.

Many of these programs are conducted at Henderson House, Northeastern University's conference center in Weston, Massachusetts.

RESEARCH ACTIVITIES

The facilities of the University are engaged in a wide variety of basic research projects in business, science, social science, pharmacy, and engineering. These are coordinated by the Dean of

Research, whose services are University-wide and available to the faculties of all the Colleges.

Although Northeastern is primarily concerned with undergraduate and graduate instruction, the University believes that the most effective teaching and learning take place in an environment characterized by research activities directed toward extending the frontiers of knowledge.



buildings and facilities

MAIN CAMPUS

The main campus of Northeastern University is located at 360 Huntington Avenue in the Back Bay section of Boston. Many of the city's famous cultural, educational, and philanthropic institutions are situated in the Back Bay, including the Museum of Fine Arts, Symphony Hall, Horticultural Hall, the Isabella Stewart Gardner Museum, the Harvard teaching hospitals, the Boston Public Library, and many schools and colleges. Most are within walking distance of Northeastern University.

Major transportation facilities serving the Boston area are Logan International Airport, two rail terminals, bus terminals serving inter- and intrastate lines, and MBTA subway-bus service within the metropolitan-suburban area. There is a subway stop in front of the campus. For motorists, the best routes to the campus are the Massachusetts Turnpike (Exit 22) and Route 9, of which Huntington Avenue is the intown section.

The campus of 48 acres is divided by Huntington Avenue, with the main educational buildings on one side and dormitories on the other. The principal buildings, all of which have been constructed since 1938, are of glazed brick in contemporary classic style. Most are interconnected by underground passageways.

Ell Student Center

The Carl S. Ell Student Center provides facilities for student recreation and for extracurricular activities. The Alumni Auditorium, with a seating capacity of 1,300, is part of the Center. Also included are special drama facilities, a ballroom, main lounge, fine arts exhibition area, student offices, conference rooms, and a dining area seating more than 1,000.

Libraries

The University library system consists of the Dodge Library, which is the main library; the Suburban Campus Library at Burlington; the School of Law Library; and divisional libraries for Physics and Electrical Engineering, Chemistry and Biology, Mathematics and Psychology, and Health, Physical and Recreation Education, and Physical Therapy. There are additional subject collections for the Center for Management Development at Andover, Massachusetts, and the Marine Science Institute in Nahant.

The library collections number 360,000 volumes supplemented by some 267,000 titles in microprint, microfilm, and microfiche forms. The collection includes, in addition, some 3,500 periodical titles, 90,000 documents, and 4,600 sound recordings.

Cabot Physical Education Center

The Godfrey Lowell Cabot Physical Education Center is one of the best equipped in New England. The large gymnasium contains four basketball courts. In addition, the Center consists of an athletic cage, a small gymnasium, and a rifle range, as well as administrative offices for the Department of Athletics and for the Physical Education Department of Boston-Bouvé College.

A recent addition to the center, the Barletta Natatorium, houses a 105-foot swimming pool, a practice tank for the crew, handball courts, and shower and dressing facilities.

Dockser Hall

Charles and Estelle Dockser Hall, completed in 1968, houses a large gymnasium, dance studio, motor performance laboratory, college library, community recreation laboratory, folk arts center, dark and music rooms, recreation resources area, locker rooms, offices, classrooms, conference room and lounge, storage facilities, and a research laboratory.

Apartments for Graduate Students

The University maintains a 100-apartment housing unit which accommodates 279 people. Two-, three-, and four-party apartments are available which vary in size from two to four rooms plus bath. Apartments are furnished with beds, chairs, desks, stove, refrigerator, and kitchen table. The cost includes all utilities.

A \$50 deposit is required when making application for the apartments. Applications are available in the Office of University Housing. Students are expected to make such arrangements on a term-to-term basis but may live in the apartments both while on cooperative work assignments and in school if they wish. All reservations are made on a first come, first served basis.

SUBURBAN FACILITIES

Suburban Campus

The Suburban Campus, located near the junction of Routes 128 and 3 in Burlington, Massachusetts, was established to meet the needs of individuals and of industry in the area.

In addition to graduate courses in engineering, physics, mathematics, business administration, science, education, and the arts, portions of undergraduate programs leading to the associate and bachelor's degrees, special programs for adults, and noncredit state-of-the-art programs are offered.

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Warren Center

The Warren Center is a practical laboratory for Boston-Bouvé College in outdoor education and conservation, in group practicum, and in camping administration, programming, and counseling. At this Center in Ashland, completed in 1967, there are tennis courts, field hockey and lacrosse fields, waterfront for swimming and boating, overnight camp sites, fields and forests, heated cottages, the Hayden Lodge with a recreation hall, library, crafts shop, dining facilities, and conference accommodations.

Henderson House

The University's conference center, Henderson House, is located in Weston, Massachusetts. The Center for Continuing Education conducts short-term courses, seminars, and special institutes for business, professional, and research groups. Henderson House is 12 miles from the main campus.

Marine Science Institute

The Marine Science Institute at Nahant, Massachusetts, is a research and instructional facility primarily engaged in studies of marine biology and oceanography. The Institute is operated all year, and is about 20 miles northeast of Boston. Many of the courses at this institute are applicable toward an advanced degree in biology or health science.

Brockton, Nashua, and Framingham Campuses

For students residing in southeastern Massachusetts and northeastern Rhode Island, the Graduate School of Business Administration offers a significant portion of its M.B.A. Program at facilities in Brockton, Massachusetts. These facilities, made available by the Knapp Corporation, are located on West Chestnut Street in Brockton.

Students residing in the southern New Hampshire area may take a significant portion of the M.B.A. Program at facilities in Nashua, New Hampshire. These facilities are furnished by Sanders Associates, Inc. and are located in their headquarters on Route 3, just over the Massachusetts line.

For students in the Framingham-Worcester area, a significant portion of the M.B.A. Program may be taken at classroom facilities located in Framingham, Massachusetts.

graduate school of business administration

The Graduate School of Business Administration at Northeastern University offers a program leading to the degree of Master of Business Administration. Broad in concept, the program is aimed at preparing the student for a career in administration rather than for an immediate or particular position. The curriculum and teaching methods center around the development of basic skills and knowledge appropriate to administration, rather than emphasizing specialized functional techniques. Although the case method of study is used extensively, a variety of teaching methods is employed that is consonant with particular course objectives. The basic objectives of the program are to increase skills and knowledge in basic disciplines underlying administrative practice, and to develop judgment and skills of problem analysis and decision making in complex organizations.

There is no prescribed undergraduate background recommended for admission. Undergraduate experiences typically include literature and the arts, mathematics and the sciences, and engineering and other applied fields. The program provides all managerial preparation appropriate to a graduate business curriculum. Flexibility allows for more intensive work in a specialized area or more general study in several fields to accommodate specific needs.

The student may choose one of four methods of securing an M.B.A. degree: full-time internship, full-time non-internship, full-time assistantship, and part-time study.

FULL-TIME STUDY

Internship

A feature which makes the Northeastern M.B.A. Program unusual in graduate education is the management internship. Following the philosophy that a balanced exposure to theory and practice is the most effective approach to management education, the 18-month program is in accord with this approach. Class work begins with basic disciplines vital to sound progress in a management-oriented course. The functional areas of business are treated next, with process courses and electives following.

This program encompasses six months of work experience in the world of business and management and 12 months of classroom study. The intern student is employed in a professional capacity within an organizational environment which provides both a realistic experience and a major source of funds for continuance of the program. The nature of the job assures ample opportunity to observe some aspect, element, or problem of the organization.

Because of economic, academic, and individual variables, the Graduate School cannot guarantee placement; however, the University has a full-time experienced staff to assist the student in obtaining his internship. A student is also encouraged to investigate employment opportunities on his own in order to facilitate final placement by the intern coordinator.

For students entering class in June an illustration of term sequence within the 18-month internship program is shown below.

	<i>1st Year</i>	<i>2nd Year</i>
SUMMER QUARTER	In Class	In Class
FALL QUARTER	In Class	In Class
WINTER QUARTER	Management Internship	In Class
SPRING QUARTER	Management Internship	

During each academic quarter the student normally carries 18 quarter hours of credit.

Thus, the full-time internship blends one full calendar year of academic study with six months of coordinated work as an intern in a business or nonprofit organization. This combination of theory and practice gives the intern excellent preparation for a career in management.

Non-internship

The full-time, non-internship allows students wide latitude in determining their pace toward the M.B.A. degree. Although most students take four courses each quarter, some take as many as five or six courses. This enables a candidate to complete degree requirements in a period from one calendar year to two academic years.

Assistantship

Under the full-time assistantship, students combine their studies with academic experience in the College of Business Administration. A student may be a teaching assistant, a graduate administrative assistant, or a tuition assistant. Appointees to these positions work directly with members of the faculty and staff of the College of Business Administration. This work affords the student interested in developing a college or university career the opportunity to explore and gain experience in teaching, research, or administration.

Teaching assistants and graduate administrative assistants receive remission of tuition and a stipend of \$2,600 in return for devoting their time respectively to assisting directly in the teaching process or in administrative duties within the College. These appointees must not take less than a half-time academic load in the M.B.A. Program. Assistants who are in the second year of study and receive a reappointment are paid a stipend of \$2,900.

Tuition assistants receive remission of tuition in return for sharing in the administrative work of the College. These awards are normally given to full-time, non-intern students in their first year of graduate work. Tuition assistants devote eight hours a week to their assigned administrative work.

PART-TIME STUDY

Part-time students may continue their full-time employment while acquiring the background, skills, and knowledge that will help them advance their careers in administration.

These students normally take two courses per quarter and may complete the degree program in three to four years, depending upon whether course work is taken during the summer quarter. All degree requirements may be completed at the Boston or suburban campuses.

Students maintaining a satisfactory academic standing may petition the Director of the Graduate School of Business Administration for permission to take more than two courses per quarter.

Thus, part-time students have the advantage of attending classes in the late afternoon and evening to learn the theory behind the practical application of their employment.

APPLICATION INFORMATION AND PROCEDURE

All applicants should address inquiries to the Graduate School of Business Administration. Application forms and reference blanks will be mailed to them. This material, together with one official transcript, the Admission Test for Graduate Study in Business (ATGSB) scores, and the results of the Test of English as a Foreign Language (TOEFL, required by all applicants whose native language is not English), should be returned to:

Northeastern University
Graduate School of Business Administration
224 Hayden Hall
Boston, Massachusetts 02115

Applications for the ATGSB Examination can be obtained by writing to:
Educational Testing Service
Box 966
Princeton, New Jersey 08540

Applications for the TOEFL Examination can be obtained by writing to
 Educational Testing Service
 Box 899
 Princeton, New Jersey 08540

Full-time non-internship, internship, and assistantship applications should be submitted by April 1.

Applications for part-time study must be completed no later than two weeks prior to the registration period for the quarter in which the applicant plans to enter the M.B.A. Program.

To be admitted for graduate work in the College of Business Administration, applicants must have completed undergraduate work of high quality and must have obtained a bachelor's degree from a recognized institution of higher learning. The overall quality of undergraduate achievement is considered to be of more importance than the particular field of specialization. Official transcripts of all previous undergraduate and graduate work must be submitted to the Graduate School of Business Administration before admission can be considered or an evaluation made.

Applicants are also required to submit three letters of reference from individuals who are familiar with their qualifications for graduate study in business administration.

The basic criteria considered in the admissions procedure are: undergraduate grades, previous graduate work, the score on the Admission Test for Graduate Study in Business, job experience, and present job level. An overall impression of strength, past success, and motivation to succeed in the Graduate School is sought in the applicants for the program.

Although the M.B.A. Program presumes no particular level of competence in the areas of accounting, economics, statistics, mathematics, and behavioral science, prospective applicants are advised to acquire some background in these areas in their undergraduate work.

GENERAL REGULATIONS

The general regulations and minimum requirements for all graduate programs are established by the Northeastern University Graduate Council. In some matters the committee of each graduate school is allowed discretion to establish regulations within limits defined by the Council. These regulations and academic requirements which follow have been formulated in accordance with this general policy.

Academic Requirements

In order to qualify for the M.B.A. degree, an average grade of B must be obtained in the total credit hours required for graduation. No more than three extra courses or repeated courses may be taken in order to satisfy this grade requirement.

Any student who receives a grade of less than B in four or more degree credit courses may be withdrawn from the program by action of the Committee of the Graduate School of Business Administration.

Within the above limitations, a required course for which a grade of I or F is received must be repeated with a grade of C or better, and may be repeated only once. If a grade of I or F is received in an elective course, that course may be repeated once with a grade of C or better, or another elective course may be substituted for it. If a grade of C is received in a required course, that course may be repeated once to obtain a grade of B or better.

The continuing development of the Graduate School forces frequent revision of curricula. In every new bulletin some revisions are indicated. When no hardship is imposed on the student because of changes, and when the facilities of the school permit, the student is expected to meet the requirements of the latest bulletin.

Application for the Degree

A commencement card must be filed with the Registrar's Office before the date specified on the University calendar. This assures the student's graduation the same year all degree requirements are completed. Prompt filing of the commencement card also insures the correct spelling on the diploma.

Classifications

Students initially entering the M.B.A. Program are classified into one of two groups depending upon their admission credentials.

Regular Students are those individuals who meet in full all admittance standards established by the Committee on Graduate Study in Business Administration.

Students in the Program for Advanced Study in Business Administration are those who already hold an M.B.A. degree. See page 45 for full information.

Continuity of Program

Students are expected to maintain continuous progress toward a degree. Any student who does not attend Northeastern for a period of one quarter without notifying the program director will be classified as inactive.

All inactive students must submit a written petition to the director of the program in order to be readmitted to graduate study. Petition forms may be obtained in Room 224 Hayden Hall.

Credits and Class Hours

All credits at Northeastern University are entered as quarter-hour credits, with a quarter hour of credit being equivalent to three fourths of a semester hour: i.e., 12 semester hours equal 15 quarter hours.

All classes in the Graduate School of Business Administration meet on a quarter basis, with an academic quarter defined as a term of approximately 12 weeks' duration. In the summer quarter, classes meet in two six-week sessions. The academic calendar at the front of this bulletin should be consulted to determine the opening dates of each quarter.

A minimum of 11 classes must be scheduled for each course during the fall, winter, and spring quarters. In a split summer session (5 and 6 weeks), a minimum of 10 classes must be scheduled in the first 5 weeks and a minimum of 11 classes in the second 6 weeks.

Grading System

The performance of students in graduate courses will be recorded by the instructor through use of the following grades:

A *Excellent*

This grade is given to those students whose performance in the course has been of very high graduate caliber.

B *Satisfactory*

This grade is given to those students whose performance in the course has been at a satisfactory level.

C *Fair*

This grade is given to those students whose performance in the course is not at the level expected in graduate work.

F *Failure*

This grade is given to those students whose performance in the course is unsatisfactory.

In addition, the following letter designations are used:

I *Incomplete*

This grade is given to those students who fail to complete the work of the course.

S *Satisfactory*

This grade is given to those students who fulfill the requirements of the course without a specific grade designation.

U *Unsatisfactory*

This grade is given to those students who do not meet the requirements of the course, although no specific grade designation is made.

These grades are used for the first quarter of a two-quarter sequence in which the grade for the second quarter applies to both the first and second quarters of the sequence.

The designation I will be changed to a grade upon removal of the deficiencies which caused the grade of I to be reported. Deficiencies must be made up within the quarter following that for which the grade of I is received, unless the instructor grants an extension of time. However, such extension may not exceed two additional consecutive calendar quarters.

A make-up final examination period will be scheduled by the Graduate School of Business Administration during the sixth week of each quarter. Any student who wishes to take a make-up examination must obtain permission of the Director of the Graduate School of Business Administration by the second week of the quarter succeeding that in which the examination was missed. The make-up examination must be taken in that succeeding quarter unless circumstances warrant the Director's permission to defer it to one of the next two quarters.

Registration

Part-time students must register during the periods listed on the school calendar. Dates of registration are specified by letter for students accepted for full-time study.

Residence

All work for advanced degrees must be completed in residence at the University, unless approval has been obtained from the Director of the Graduate School of Business Administration for work taken elsewhere. Students who are in residence and are using the facilities of the University must register for such work.

Time Limitation

Course credits earned in the program of graduate study, or accepted by transfer, are valid for a maximum of seven years.

Transfer Credit

A maximum of 15 quarter hours of graduate credit obtained at another institution may be accepted toward the master's degree, provided that the credits transferred carry grades of A or B, have been earned at a recognized institution, have not been used toward any other degree, and are relevant to the M.B.A. Program. Students should petition the Graduate School of Business Administration in writing for all transfer credit. Petition forms may be obtained in Room 224 Hayden Hall. Grades on transfer courses are excluded in the computation of the academic average necessary for the completion of the degree requirements.

Waiver of Courses

Certain required courses may be waived if a student can demonstrate that the course material would be a repetition of previous academic training. Course waivers are subject to faculty approval and do not entitle a student to transfer credit. An elective must be substituted for each required course which is waived. Questions concerning course waivers should be directed

to the Director of the Graduate School of Business Administration at least 30 days prior to the quarter in which the student is scheduled to take the course.

Withdrawals

In order to withdraw from a course, a student must submit an official withdrawal form obtained at the Registrar's Office or at the Suburban Campus Main Office. Withdrawals may be made through the ninth class meeting of the quarter. Students are withdrawn as of the date on which they submit the form. Ceasing to attend a class or notifying the instructor does not constitute an official withdrawal.

Petitions for withdrawal from a course after the ninth class meeting of the quarter must be submitted to the Director of the Graduate School, and may be approved to avert unusual hardships on a student. Petition forms may be obtained in Room 224 Hayden Hall.

financial information

FINANCIAL OBLIGATIONS

Tuition

Tuition for master's degree candidates and special students is \$55.00 per quarter hour of credit. Since each graduate course is three credit hours, the cost for each course is \$165.00.

Tuition statements are mailed to students by the Bursar's Office and are payable by check to Northeastern University on or before the date specified.

Fees

All applications must be accompanied by an application fee (nonrefundable) of \$15.00. No applications will be processed until the fee has been received by the Graduate School of Business Administration. Checks should be made payable to Northeastern University and sent directly to the Office of the Graduate School of Business, 224 Hayden Hall.

Upon notification of admission, all full-time applicants are required to pay a tuition deposit of \$50.00. This deposit is credited to the student's tuition, and is not refundable for those who do not register.

Other fees include: a charge of \$10.00 for late payment of tuition; a final examination make-up fee of \$5.00; and a fee of \$25.00 for all degree candidates, payable before commencement by the applicable date listed on the academic calendar.

For full-time students there is a charge of \$12.50 per quarter for the services available in the Student Center. The fee for tuition assistants, teaching assistants, and administrative assistants is \$6.25 each quarter. All part-time students on the Huntington Avenue Campus are charged \$.75 a quarter.

All full-time students will pay a nonrefundable University Health Services fee of \$75.00 each year. This fee provides Blue Cross-Blue Shield coverage and entitles the student to the medical care furnished by the University Health Services.

All financial obligations to the University must be discharged before graduation.

Refunds

Tuition refunds are granted only on the basis of the date appearing on the official withdrawal form filed by the student. Nonattendance does not constitute official withdrawal. Questions regarding refunds should be discussed with the Bursar's Office.

Refunds will be granted in accordance with the following schedule:

<i>Official Withdrawal Filed Within</i>	<i>Percentage of Tuition Refunded</i>
First week of quarter	100
Second week of quarter	75
Third week of quarter	50
Fourth week of quarter	25

FINANCIAL AID

The Graduate School of Business Administration grants financial aid in the form of assistantships, internships and Sloan scholarships. A description of assistantships and internships can be found on page 27. The Sloan program is described below. Northeastern University also has a limited amount of financial aid for full-time students enrolled in the Graduate School of Business Administration. Information in addition to that below, and application forms, are available from the Northeastern Office of Financial Aid. These forms are not available in the Graduate School of Business Administration Office.

Dormitory Proctorships

A number of proctorships in men's dormitories on or near the Huntington Avenue Campus is available each year. Appointments carry a minimum compensation of room and board. Further information and application forms may be obtained from the Office of University Housing.

Guaranteed Student Loan Program

Under this program, students who are matriculated degree candidates, enrolled for at least one-half the normal academic work load, may borrow from a participating bank or other financial institution. Terms and conditions vary from state to state, but a student generally may borrow up to \$1,500 a year (the law allows a maximum of \$2,500 per year) depending on financial need. The Federal government pays the interest while the student is in school if the student is eligible for interest subsidy.

The student must have submitted, through the College Scholarship Service, a Parents' Confidential Statement; or if he has been declared financially independent by the Financial Aid Office, a Students' Confidential Statement. These forms are available in the Financial Aid Office.

Applications for the loan itself are available from local banks or the Education Office of your state government. Additional information and necessary application forms for Massachusetts residents are available from the Financial Aid Office.

Martin Luther King, Jr., Fellowships

A limited number of full-time Martin Luther King, Jr., Fellowships are available. Holders of these appointments devote full time to graduate work.

National Direct Student Loan

This program is available to students who are carrying at least one-half the normal academic work load, are accepted as degree candidates, and who show evidence of financial need.

The Federal maximum which a graduate student may borrow while pursuing a post-baccalaureate degree is \$5,000.

Repayment and interest on these loans do not begin until nine months after the student ceases to carry at least a half-time academic load at an institution of higher education. The repayment of principal may be extended over a 10-year period with the interest at the rate of three percent per annum. Repayment may be deferred up to a total of three years while a borrower is serving as a Peace Corps or VISTA volunteer.

The Sloan Scholarship Program

The Sloan Program provides funding for certain minority students who are pursuing the MBA degree on a part-time basis. Under terms of the grant, minorities eligible for funding are Americans who are black, Spanish speaking, or of oriental descent. By attending classes in the late afternoon and evening, part-time students combine practical work experience from their regular responsibilities with appropriate theoretical knowledge.

Qualified students who have been out of school at least five years and feel their career progress has not fulfilled expectations should apply. Additional graduate study leading to an MBA degree facilitates career progress.



faculty

- Robert F. Abbanat**, *Lecturer in Business Administration*; B.S., M.S., Massachusetts Institute of Technology; M.B.A., D.B.A., Harvard University
- Dean S. Ammer**, *Director, Bureau of Business and Economic Research, and Professor of Management*; B.S., Massachusetts Institute of Technology; M.B.A., Ph.D., New York University
- Harley H. Anderson**, *Assistant Dean, Lecturer in Business Administration*; B.S., M.B.A., Northeastern University; J.D., Suffolk University
- Matthew D. Arnett**, *Assistant Professor of Business Administration*; B.S., Purdue University; B.D., University of Chicago; Ph.D. Candidate, University of Cincinnati
- Robert H. Caplan, III**, *Professor of Management*; B.C.E., Cornell University; M.B.A., D.B.A., Harvard University
- Clairmont P. Carter**, *Assistant Professor of Accounting*; B.A., Pennsylvania State University; M.B.A., Akron University; D.B.A., Kent State University
- John J. Castellano**, *Assistant Professor of Business Administration*; B.S., University of New Hampshire; M.B.A., St. Louis University; Ph.D. Candidate, State University of New York at Buffalo
- Saverio Cerullo**, *Associate Professor of Finance*; B.S., M.B.A., Boston University
- Lal C. Chugh**, *Assistant Professor of Business Administration*; Bachelor of Commerce, Delhi Polytechnic Institute; M.A., Delhi School of Economics; Ph.D., Harvard University
- Charles J. Collazzo, Jr.**, *Professor of Marketing*; B.A., Northeastern University; M.C.S., M.A., Boston University; Ph.D., Columbia University
- Paul V. Croke**, *Associate Professor of Management*; A.B., M.B.A., Boston College; Ph.D., Rensselaer Polytechnic Institute
- Philip T. Crotty, Jr.**, *Associate Dean, College of Business Administration and Associate Professor of Management*; A.B., Holy Cross College; A.M., Harvard University; M.B.A., Ed.D., Boston University
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- Charles H. Dutton**, *Coordinator, Marketing Group, and Professor of Marketing*; A.B., Yale University; M.A., University of Michigan
- Paul R. Egan**, *Lecturer in Business Administration*; B.S., St. Mary's College; M.B.A., Xavier University
- Edwin F. Estle**, *Lecturer in Business Administration*; B.S., Purdue University; M.A., Ph.D., Princeton University
- Robert H. Farrar**, *Assistant Professor of Accounting and Management*; B.S.B.A., M.B.A., Northeastern University; Ph.D., University of Massachusetts
- Michael Feters**, *Assistant Professor of Business Administration*; B.S., Ohio State University; M.B.A., Ph.D., University of Wisconsin
- Ralph W. Fingar**, *Lecturer in Business Administration*; B.S., Union College; Ph.D., University of Texas
- Angelo Fiumara**, *Associate Professor of Business Law*; A.B., J.D., Boston College
- Victor Godin**, *Assistant Professor of Business Administration*; A.B., B.S., Columbia University; M.S., Massachusetts Institute of Technology; D.B.A., Harvard University
- Joseph M. Golemme**, *Harold A. Mock Professor of Accounting, and Director, Graduate School of Professional Accounting*; B.S., Northeastern University; M.A., Boston University; C.P.A.
- Herbert Graetz**, *Assistant Professor of Business Administration*; B.S., Chemical Engineering, Massachusetts Institute of Technology; M.B.A., Harvard University; D.B.A. Candidate, Harvard University

- Carlo E. Gubellini**, *Coordinator, Accounting Group, and Professor of Management*; B.S., Northeastern University; M.B.A., Boston University
- Robert J. Hehre**, *Associate Professor of Finance and Accounting*; B.S., M.S., Columbia University; M.B.A., D.B.A., Indiana University; C.P.A.
- James S. Hekimian**, *Dean of Business Administration and Professor of Management*; A.B., M.B.A., D.B.A., Harvard University
- Richard B. Higgins**, *Professor of Management*; A.B., Tufts University; Ph.D., Columbia University
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- Paul Janell**, *Assistant Professor of Business Administration*; B.S., Northeastern University; M.B.A., Babson College; Ph.D., Michigan State University
- John W. Jordan**, *Assistant Dean and Director, Graduate School of Business Administration*; B.S., M.S., State College at Boston
- Lyman A. Keith**, *Professor of Management*; B.S., Northeastern University; M.A., M.B.A., Boston University
- Raymond M. Kinnunen**, *Assistant Professor of Business Administration*; B.S., M.B.A., Northeastern University; D.B.A., Louisiana State University
- Robert C. Lieb**, *Associate Professor of Management*; B.S., Duquesne University; M.B.A., D.B.A., University of Maryland
- Richard Lindhe**, *Associate Professor of Accounting*; B.S., M.Ed., Kent State University; Ph.D., University of Chicago
- John Macey**, *Lecturer in Business Administration*; B.S., Massachusetts Institute of Technology; M.S., Northeastern University
- Lawrence H. Malchman**, *Professor of Accounting*; B.S., Ed.M., Boston University; C.P.A.
- Maureen Malin**, *Lecturer in Business Administration*; A.B., Radcliffe College; M.B.A., Ed.D. Candidate, Harvard University; Ph.D. Candidate, Massachusetts Institute of Technology
- Wesley W. Marple, Jr.**, *Coordinator, Finance Group, and Professor of Finance*; A.B., Princeton University; M.B.A., D.B.A., Harvard University
- Edward S. Marshall**, *Associate Professor of Management*; M.A., University of Chicago; Ph.D., State University of Iowa
- Daniel J. McCarthy**, *Professor of Management*; A.B., M.B.A., Dartmouth College; D.B.A., Harvard University
- Philip R. McDonald**, *Professor of Marketing and Management*; B.A., University of British Columbia; M.B.A., D.B.A., Harvard University
- Robert J. Minichiello**, *Professor of Marketing*; A.B., Harvard University; M.B.A., Boston University; D.B.A., Harvard University
- Mark M. Moriarty**, *Assistant Professor of Marketing and Management*; B.S.I.M., Purdue University; M.A., University of California, Los Angeles; Ph.D., Purdue University
- Richard P. Nielson**, *Assistant Professor of Business Administration*; B.S., M.A., Wharton School of Finance; Ph.D., Syracuse University
- Russell W. Olive**, *Coordinator, General Management Group, and Professor of Management*; B.S., M.A., Massachusetts Institute of Technology; M.B.A., Boston University; D.B.A., Harvard University; P.E.
- Robert A. Parsons**, *Assistant Professor of Management*; B.S., M.B.A., Northeastern University; M.A., Ph.D. Candidate, Boston College
- Andre P. Priem**, *Associate Professor of Management*; B.B.A., M.A., University of Cincinnati
- Paul C. Richards**, *Lecturer in Business Administration*; B.S., M.B.A., Northeastern University; C.P.A.
- Herman Rochwarg**, *Associate Professor of Management*; B.A., Ph.D., Michigan State University
- Anghel N. Rugina**, *Professor of Economics and Finance*; B.S., College of Business, Goltz, Rumania; M.A., Ph.D., Academy of High Studies in Economics, Bucharest, Rumania; Ph.D., University of Freiburg, Germany
- Richard J. Santos**, *Associate Dean and Director, Center for Management Development, and Associate Professor*; B.S., Salem State College; M.A., Emerson College
- Daniel C. Scioletti**, *Associate Professor of Business Law*; B.B.A., Colby College; LL.B. Suffolk University; Ed.M., Boston University
- Henry H. Seward**, *Lecturer in Business Administration*; B.A., Yale University; M.B.A., Michigan State University; D.B.A., Harvard University
- Charles Shelley**, *Assistant Professor of Business Administration*; B.B.A., University of Massachusetts; Ph.D., University of Massachusetts

- Albert Slavin**, *Lillian L. and Harry A. Cowan Professor of Accounting*; Ed.B., Ed.M., Boston University; C.P.A.
- Frederick J. Stephenson**, *Assistant Professor of Business Administration*; B.A., B.S., University of Minnesota; Ph.D. Candidate, University of Minnesota
- Jeffrey A. Timmons**, *Associate Professor of Management*; A.B., Colgate University; M.B.A., D.B.A., Harvard University
- Raymond Ward**, *Assistant Professor*; B.S., Purdue University; Ph.D. Candidate, University of California at Berkeley
- Edward R. Willett**, *Professor of Finance*; B.S., Northeastern University; M.A., Ph.D., Harvard University
- Frederick Wiseman**, *Associate Professor of Marketing*; B.S., Tufts University; M.S., Ph.D., Cornell University



master of business administration curriculum

Candidates for the degree of Master of Business Administration must complete successfully 24 courses (72 quarter hours of credit), 17 of which are required courses and 7 are elective courses.

Required Courses

<i>Number</i>	<i>Courses</i>	<i>Credit Hours</i>
41.811	Financial and Managerial Accounting	3
41.812	Control I	3
41.813	Control II	3
43.811	Marketing Management I	3
43.812	Marketing Management II	3
44.811	Financial Management I	3
44.812	Financial Management II	3
45.805	Operations Management I	3
45.806	Operations Management II	3
45.815	Behavioral Concepts	3
45.816	Organizational Behavior I	3
45.817	Organizational Behavior II	3
45.836	Policy: the Social, Political, Economic, and Legal Environment	3
45.837	Policy: the Formulation and Implementation of Strategy	3
49.901	Managerial Economic Analysis	3
49.902	Quantitative Analysis I	3
49.903	Quantitative Analysis II	3
Total Required Credit Hours		51
Elective Credit Hours		<u>21</u>
Total Credit Hours for Degree		72

Elective Courses

In addition to the required courses, students must complete course work in electives to bring their total program to the 72 quarter hours of credit required for the Master of Business Administration degree. All elective courses carry three quarter hours of credit unless otherwise specified.

Courses may also be selected from other graduate programs at North-eastern University with the permission of the director of the appropriate program and the Director of the Graduate School of Business Administration.

Administration and Its Environments		44.935	Management of Financial Institutions
39.805	Business Cycles and Forecasting		
39.823	Government Finance		
39.825	Fiscal Policy		
39.831	Money and Banking		
39.835	Labor Economics		
41.862	Tax Factors in Business Decisions		
45.821	Policy Formation in Non-Business Institutions		
45.841	Public/Private Service Systems		
45.962	Institutional Environment of Business I		
45.964	Institutional Environment of Business II		
45.969	Government and Business		
45.989	Science and Technology: The Challenge of Management		
45.991	Business Law—Law of Contracts, Agency and Sales		
45.992	Law of Business Organizations and Negotiable Instruments		
		General Management	
		45.811	Purchasing and Materials Management
		45.828	Seminar in Growth Strategies for Corporate Management
		45.830	Formal Planning Systems
		45.839	Women Managers
		45.997	Special Topics in Business Administration (1 to 3 Q.H.)
		45.998	Administration (1 to 3 Q.H.)
		45.999	Administration (1 to 3 Q.H.)
		49.932	Introduction to Computer Applications
		49.933	The Computer and Its Applications II
		49.935	Computer Applications in Management Science
Financial Management			
44.814	International Financial Management		
44.816	The Management of Financial Resources		
44.818	Working Capital Management		
44.901	Finance III—Advanced Financial Management		
44.921	Investment Analysis		
44.924	Mergers and Negotiable Instruments		
		Health Care Administration	
		45.808	Comparative Management
		45.833	Operations Management in the Health Care System
		45.838	Policy Formation in Health Care
		45.975	Introduction to Health Care Systems
		45.976	Workers in the Health Care System
		45.977	Information Systems for Health Care Facilities
		49.918	Information Theory and Systems

International Business Management

- 39.827 Economic Development
- 39.829 Comparative Economic Systems
- 39.833 International Economics
- 44.814 International Financial Management

Management of Human Resources

- 45.808 Comparative Management
- 45.819 Interpersonal Behavior
- 45.820 Psychological Dynamics of Leadership
- 45.823 Career Planning and Development
- 45.824 Organizational Behavior in a Non-Profit Environment
- 45.835 Seminar in Organizational Development
- 45.951 Executive Development
- 45.971 Personnel Management
- 45.972 Labor Relations
- 45.973 New Sectors of Collective Bargaining
- 45.976 Workers in the Health Care System
- 45.985 Management of Research and Development
- 45.993 Labor Law

Management of Transportation and Logistics

- 48.801 Seminar in Inter-city Transportation
- 48.805 Urban Transportation
- 48.901 Physical Distribution Management

Managerial Control

- 41.815 Management Control Systems
- 41.816 Management Control of Health Service Systems
- 41.825 Management Performance Appraisal
- 41.862 Tax Factors in Business Decisions

Marketing Management

- 43.814 Consumer Behavior
- 43.910 International Marketing
- 43.925 Sales Management
- 43.926 Advertising Management
- 43.931 Marketing Research
- 43.934 New Product Development
- 43.936 Strategy Problems of Mass Distributors
- 43.937 Marketing in the Public Sector
- 43.941 Industrial Marketing

Operations Management

- 45.809 Advanced Operations Management
- 45.833 Operations Management in the Health Care System
- 45.902 Planning and Control of Manufacturing Operations
- 45.965 Management of Small Business Enterprises
- 49.904 Contemporary Problems in Managing Complex Operating Systems
- 49.907 Operations Management Game

Small Business Management

- 45.829 New Ventures: A Career Choice
- 45.965 Management of Small Business Enterprises
- 45.968 Management of New Enterprises

Recommended Part-Time Program

While the part-time student has some flexibility in the order in which he takes his required work, the schedule below is recommended as a guide:

<i>Quarter</i>	<i>Number</i>	<i>Course</i>
1st	41.811	Basics of Financial and Managerial Analysis
	45.815	Behavioral Concepts
2nd	41.812	Control I
	45.816	Organizational Behavior I
3rd	41.813	Control II
	45.817	Organizational Behavior II
4th	49.901	Managerial Economic Analysis
	49.902	Quantitative Analysis I
5th	49.903	Quantitative Analysis II
		Elective
6th	43.811	Marketing Management I
	44.811	Financial Management I
7th	43.812	Marketing Management II
	44.812	Financial Management II
8th	45.805	Operations Management I
		Elective
9th	45.806	Operations Management II
		Elective
10th	45.836	Policy: the Social, Political, Economic, and Legal Environment
		Elective
11th	45.837	Policy: the Formulation and Implementation of Strategy
		Elective
12th		Elective
		Elective

OTHER GRADUATE-LEVEL PROGRAMS IN BUSINESS**The Center for Management Development**

The Center for Management Development offers the Management Development Program, designed for experienced managers who have had responsibility for a major task, function, department, division, or independent enterprise. Its general aim is to improve the manager's overall performance.

There is a choice of two six-week sessions spaced over five months, October through February or January through May. Participants attend two consecutive weeks of classes at the outset, and thereafter one week in each of the remaining four months. This approach offers a tested

alternative to organizations which recognize the need for management training, but find it difficult to release a key man for long periods of study. A certificate is awarded upon successful completion of course work.

Management Development Program

The Management Development Program is a graduate-level course in business, designed for experienced managers who have had responsibility for a major task, function, department, division, or independent enterprise. Its general aim is to improve the manager's overall performance.

There is a choice of two six-week sessions spaced over five months, October through February or January through May. Participants attend two consecutive weeks of classes at the outset and thereafter one week in each of the remaining four months. This approach offers a tested alternative to organizations which recognize the need for manager training but find it difficult to release a key man for lengthy periods of study. A certificate is awarded to all who successfully complete the course work.

Graduate School of Professional Accounting

The Graduate School of Professional Accounting offers a 15-month program for non-accounting majors that leads to the degree of Master of Science in Professional Accounting. This unique program combines 12 months of class work with a three-month internship in a public accounting firm.

Information may be obtained by writing to:
Graduate School of Professional Accounting
206 Hayden Hall
Northeastern University
Boston, Massachusetts 02115

The Program for Advanced Study in Business Administration

The Program for Advanced Study in Business Administration has been instituted through the Graduate School of Business Administration. The main objective is to provide advanced work in business administration to meet the needs of a rapidly changing environment. Anyone who holds an M.B.A. or its equivalent is eligible. For further information contact the office of the Graduate School of Business Administration.



description of courses

39.805 Business Cycles and Forecasting

Analysis of positive and negative characteristics of modern capitalism followed by a presentation of short- and long-run problems of economic and financial instability. Dynamic models of economic fluctuations, development of economic indicators, and survey data are used to understand the problem of forecasting. An evaluation of conceivable stabilization policies and programs is included. *Prep. 15 Q.H. Grad. Credit.*

39.823 Government Finance

A survey of governmental expenditure, revenue, and debt systems, with emphasis upon their economic effects and their relationship to principles of economic welfare. Discussions of taxation, tax incidence, tax theory, debt management, and employment levels. *Prep. 15 Q.H. of Grad. Credit.*

39.825 Fiscal Policy

Development of a conceptual framework to assess the impact of government policies on attaining full employment, price stability, economic growth, and other economic goals of the public sector. Special emphasis is given to conflicts resulting from simultaneously trying to achieve all goals while combating the problems of inflation and stagnation. *Prep. 15 Q.H. of Grad. Credit.*

39.827 Economic Development

The study of the process of structural change in the course of economic development, with emphasis on the causes and consequences of growth. Models depicting the mobilization and allocation of resources are presented, along with an examination of the cultural and political obstacles to production and distribution in underdeveloped countries today. The theoretical analysis is supplemented with case studies. *Prep. 15 Q.H. of Grad. Credit.*

39.829 Comparative Economic Systems

A comparative study of central economic theories and institutions of Capitalism, Socialism, Communism, and the Welfare State. Particular attention to criteria for evaluating success in meeting diverse goals, techniques and problems of planning, and real growth rates. *Prep. 15 Q.H. of Grad. Credit.*

39.831 Money and Banking

A study of the nature and function of the monetary and banking systems of the United States and of alternative theoretical models of the relationships between money and economic activity. Current issues in monetary theory and policy and international finance are considered. *Prep. 15 Q.H. of Grad. Credit.*

39.833 International Economics

Four areas, history, theory, policy and doctrine, are considered in relating the United States to the rest of the world, with emphasis on theory and policy. A study of money, gold- and/or paper-currency, in international trade and capital movements and the balance of payments are combined with evaluated proposals for international mone-

tary system reforms and other trade agreements recommending more cooperation and integration. *Prep. 15 Q.H. of Grad. Credit.*

39.835 Labor Economics

The economics of wage determination, impact of unions on wages and inflation, the economics of full employment and unemployment, and private and public remedial policies; the labor force, governmental labor legislation, security, unionism, and democracy. *Prep. 15 Q.H. of Grad. Credit.*

41.811 Financial and Managerial Accounting

An introduction to accounting systems, including the development of financial statements. Includes a critical appraisal of analytical techniques of evaluating the firm's potential through historical data. *Prep. none.*

41.812 Control I

After examining the role which profit maximization plays as an entity objective, alternative courses of action for goal achievement are integrated into a programmed budgeting process. Emphasis is given to the budget as a planning, motivating, coordinating, evaluating, and re-planning device. *Prep. 41.811.*

41.813 Control II

A study of the integration and coordination of short-range programs with long-range plans and the control mechanisms which enhance appropriate conformance with the strategic budget. Primary emphasis is on organizations decentralized into divisional units. *Prep. 41.812.*

41.815 Management Control Systems

Management control is the process by which management translates the organizational objectives and strategy into specified goals for attainment in a specified period of time, and secures the effective accomplishment of these goals in an efficient manner. This course deals with systems that facilitate this process, with particular attention to those designed for use at divisional and top management levels. *Prep. 41.813.*

41.816 Management Control of Health Service Systems

The objective of this course is to develop a competence in conceptualizing and managing the planning and control requirements of organizations operating in the health services domain. Major topics include: planning, budgeting, responsibility accounting, cost analysis, and cost control. The role of the controller in these activities is also examined. The course embodies the idea of a system's integrating these requirements. *Prep. 15 Q.H. of Grad. Credit.*

41.825 Management Performance Appraisal

A critical examination of traditional management appraisal, as well as recently proposed techniques. External appraisal of aggregate management performance and internal appraisal of individual management performance are covered. *Prep. 41.812.*

41.862 Tax Factors in Business Decisions

A survey of the Internal Revenue Code and its implications for choice of organizational form, corporate reorganizations, compensation policies, and foreign business operations. Mergers and acquisitions and the management of depreciable property are

examined in the light of decisions made by the Internal Revenue Service and the tax courts. The emphasis is on discussion and research into corporate income tax problems that affect business decisions. *Prep. 15 Q.H. of Grad. Credit.*

43.811 Marketing Management I

The objectives of Marketing Management I and II are twofold: 1. to provide the student with a comprehensive understanding of basic marketing functions, institutions, and concepts; and 2. to develop the student's ability to analyze and make recommendations about business problems that involve the creation, distribution, and sale of goods and services. Marketing Management I emphasizes the definition of marketing problems, demand analysis, consumer analysis, and market research. *Prep. none.*

43.812 Marketing Management II

A continuation of Marketing Management I, with emphasis on the formulation and implementation of marketing strategy. Emphasis is placed on product policy, channels of distribution, pricing, advertising, personal selling, and the development of integrated marketing programs of action. *Prep. 43.811.*

43.814 Consumer Behavior

Development of an understanding of consumer attitudes and behavior processes. Various economic and behavioral models of consumer behavior are examined and evaluated as bases for the planning and evaluation of marketing strategies. Text, readings, project. *Prep. 43.811.*

43.910 International Marketing

Objective is to develop an understanding of: 1. the opportunities and challenges facing the international marketing executive; 2. the decision-making process in marketing goods abroad; and 3. the environmental forces—economic, cultural and political—affecting the marketing process and acting as constraints on the development of marketing strategies abroad. Lectures, discussions, reports, and cases. *Prep. 43.811.*

43.925 Sales Management

Designed to help the student develop both the understanding and decision-making skills necessary to build and maintain an effective sales organization. Cases and readings are used which examine the strategic and operating problems of the sales manager. Four major topic areas are: 1. the selling function, 2. sales management at the field level, 3. the sales executive, and 4. sales and marketing management. *Prep. 43.812, or permission of the instructor.*

43.926 Advertising Management

An overview of management's role in the creation, administration and evaluation of advertising. Readings, discussions, and cases develop knowledge of the four fundamental steps in advertising management and strategy — markets, media, messages, measurement — in marketing consumer and industrial goods and services, and in communications. Topics covered include the role of promotion and communication within the marketing mix, market identification and media strategy, development of advertising messages, program evaluation, the advertiser-agency relationship, and advertising and social issues. *Prep. 43.812 or permission of the instructor.*

43.931 Marketing Research

Major methods and techniques of marketing research are examined to understand the function of research in marketing decision making. Specific topics include research design, determination of information requirements, data collection methods, experimentation, sampling, data analysis, and use of the canned program. *Prep. 43.811 and 49.902.*

43.934 New Product Development

The importance of new products to the survival and prosperity of firms continues to grow with increasing shortening of product life cycles; with changes in technology, competition, and consumer tastes; and with increasing operating costs. For most firms, coping with the problems of environmental change through modification of the product line is both vital and difficult. This seminar will have as a primary concern the examination and analysis of some of the problems firms face in directing and managing their new product development activities. *Prep. 43.812, Marketing Management II.*

43.936 Retail Management

Examines selected major strategy problems facing large-scale food and general merchandise distributors; selects store locations; determines merchandising and promotional policies; and formulates long-range plans. Cases and issues are explored from the viewpoint of the management of prominent supermarket, department store, and discount retailers, with some attention to wholesalers. Designed primarily for students interested in retailing or wholesaling, and those concerned about mass distribution in marketing consumer goods. *Prep. 43.812.*

43.937 Marketing Public Goods and Services

Examines public/private institutional systems involved in providing public goods and services (e.g., health care, housing, education, transportation, defense-aerospace-oceanographic, pollution control, law enforcement) from the standpoint of business markets and participation. Emphasis on the relevant marketing (buyer-seller) and non-marketing relationships between firms and other institutions involved in policy making, service provision, and procurement. *Prep. 15 Q.H. or permission of the instructor.*

43.941 Industrial Marketing

The problems of industrial concerns in marketing their products and services to industrial, business, and organizational customers. Emphasis is placed on determining these customers' needs and on developing programs to satisfy these needs. Topics include the roles and responsibilities of the marketing executive engaged in industrial distribution, advertising, and research, as well as roles and responsibilities of industrial salesmen, sales supervisors, and selling agents. *Prep. 43.812.*

44.811 Financial Management I

This course and its required sequel, 44.812, acquaint students with concepts, practices, and procedures of financial management and offer training in analytical approaches which help them make wise decisions affecting the flow of funds within an organization. Instruction is primarily through readings and cases. *Prep. 41.813.*

44.812 Financial Management II

Concentrates on long-term sources and uses of funds, with an introduction to capital budgeting techniques and the concept of cost of capital. Risk and return trade-offs

are included. Broad topics of overall financial strategy and timing are examined. Frequently, evening students are required to prepare a term report based upon data gathered on their jobs and/or from financial literature. *Prep. 44.811.*

44.814 International Financial Management

Comprehensive coverage of the field of international financial management, including the fundamental problems of financial forecasting, multinational capital budgeting, affiliate financial structures, international fund movements and instruments of international finance, import-export financing, and the characteristics of foreign environments. Background information is sought in the interpretation of U.S. foreign investment controls and the reaction of foreign governments to U.S. interference. *Prep. 44.812.*

44.816 The Management of Financial Resources

Conceptually, decisions regarding the sources and uses of long term funds should be made simultaneously. This course examines both aspects of the decision. A thorough analysis of capital budgeting techniques are combined with an assessment of factors affecting a firm's capital structure. Company assets and how they should be financed are the central questions. *Prep. 44.812.*

44.818 Working Capital Management

The current assets and liabilities sections of an organization's balance sheet determine the amount of long term capital committed to working capital uses. This course examines strategies and analytical approaches for making wise decisions affecting these amounts. Material on money market conditions is included. *Prep. 44.812.*

44.901 Finance III—Advanced Financial Management

An opportunity to study several important areas of financial management in greater depth than is possible in the basic finance courses. Some of the topics are: corporate capital structure, dividend policy, capital budgeting, and the management of current assets. Instruction is primarily through assigned readings and classroom case discussions. *Prep. 44.812.*

44.921 Investment Analysis

Investment principles and risks. The objective is the development of a sound investment program, with attention to identification of investment objectives and risks. Emphasis is placed on the techniques of analysis and evaluation of various types of securities and the associated risks, the operation of the securities markets, and the various methods of portfolio management. *Prep. 15 Q.H. of Grad. Credit.*

44.924 Mergers and Acquisitions

This seminar explores the economic environment which has recently given rise to a large number of corporate mergers and the business factors underlying these corporate combinations. The financial, managerial, accounting, and legal factors affecting mergers are studied. Students learn how to appraise a potential merger and structure a merger on advantageous terms. Instruction is through directed readings, case discussions, and independent research. *Prep. 44.812.*

44.935 Management of Financial Institutions

The intent is to acquaint students with the broad range of decision-making problems faced by major financial institutions such as commercial banks, savings and investment institutions, and finance companies when viewed as competitive, profit-seeking

business entities. Major areas of concern in the course are: sources and uses of funds by financial institutions, competition, regulation, and strategic policy planning by financial institutions. Instruction is primarily through readings and cases. *Prep. 44.812.*

45.805 – 45.806 Operations Management I & II

The primary objective is to develop understanding of management in the operations system—its design operation, control, evaluation, and modification. Two second objectives: (1) to increase capability for managerial decision making in technical matters; and (2) to develop an appreciation of the operations manager's job. Topics include: design of product, design of process, human factors engineering, development of capacity, line balancing, man-machines systems, work measurement, job evaluation, wage payments system, project network models, production planning, inventory management, production scheduling and control, and management of product quality and statistical quality control. Operations Management I concentrates on the design of the operations system; whereas Operations Management II focuses on the operation and control. *Prep. Basic courses in accounting and control, finance, quantitative analysis, and organizational behavior or permission of the instructor. Prep. 45.805 for 45.806.*

45.808 Comparative Management

An analysis of the management process in different types of organizations with emphasis on similarities. Among the types of organizations examined are: business firms, school systems, colleges and universities, unions, political parties, prisons, hospitals, churches, and military organizations. *Prep. 15 Q.H. of Grad. Credit.*

45.809 Advanced Operations Management

This course is designed for those whose career goals are positions of responsibility in the management of the manufacturing or operations function of an enterprise. Although the primary focus is upon manufacturing enterprises, complex operating problems in service-oriented institutions are included. Drawing primarily upon case studies, the course focuses on the development and implementation of detailed responses to the management requirements of operating systems. Emphasis is given to emerging technological developments, such as computer-based mechanization and automation, and to new developments in several areas of production and operations management. *Prep. 45.806.*

45.810 Operations Management in the Service Sector

Since the concepts and techniques of Operations Management were first developed in manufacturing settings, traditional courses in operations management have dealt with manufacturing. These concepts and techniques have wide applicability in service and non-profit sectors which need the tools and techniques already used in manufacturing. Concentration is on application of concepts and techniques in the service sector. Industries include: restaurant, health-care, recreation, brokerage, insurance, and airline. *Prep. 45.805 or permission of the instructor.*

45.811 Purchasing and Materials Management

Specialized managerial skills are related to purchasing and other materials management activities. Although primarily industrial, the same principles are applied to non-profit, non-manufacturing organizations. Instructor uses both text and cases, as well as extensive personal experience. *Prep. 15 Q.H. of Grad. Credit.*

45.815 Behavioral Concepts

A brief examination of major concepts and findings of the behavioral sciences which have particular pertinence to business and administration. Systematic ways of understanding behavior are developed, taking account of technical, economic, political, and human factors. Individual development is studied from the standpoint of character, perception, learning, and motivation. Behavior of people in small groups is also examined in terms of the structure and dynamics of the individuals in the group. *Prep. none.*

45.816 Organizational Behavior I

Basic findings and concepts of the behavioral sciences are related to the specific aspects of behavior in formally constituted organizations. Supervisory behavior is examined in the behavioral context, as well as relations between groups, in order to develop ways of achieving collaboration. *Prep. 45.815.*

45.817 Organizational Behavior II

The study of behavior in organizations is expanded to larger organizations in order to understand and deal systematically with the complex relationships found at this level. This course also provides an opportunity to apply knowledge about people in organizations to the improvement of organizational systems and to the process of achieving changes in organizations. *Prep. 45.816.*

45.819 Interpersonal Behavior

An intensive inquiry into communications from one person to another, the longest distance of all. Makes use of unconventional media for learning (selected films, drama, and the short story) in which universal qualities of the interactions between people are described, analyzed, and reinterpreted to different settings in today's world. *Prep. none.*

45.820 Psychological Dynamics of Leadership

Reviews the existing approaches and hypotheses about the nature of leadership. Focuses on psychoanalytic theory as a foundation from which to understand leadership behavior. An extensive case history provides material for class discussion and illustration of the theories of leadership. *Prep. 15 Q.H. of Grad. Credit.*

45.821 Policy Formulation in Nonbusiness Institutions

This seminar focuses primarily on the decision-making process in government institutions, primarily at the Federal level. Readings portray nonrational perspectives on behavior, such as the cybernetic and political models of decisions. Their larger aim is to develop awareness of cognitive limitations of public policy decision-makers and the inherent dysfunctions of bureaucracies in which they operate. Class sessions explore the evolution of public policy, the role of analysis in policy formulation and implementation, and the methodology of policy analysis. The seminar is concerned with strategic decisions rather than with day-to-day operating problems. *Prep. 15 Q.H. of Grad. Credit.*

45.823 Career Planning and Development

Effective career planning and development is best viewed through the larger context of an individual's actualization process in life. Career evaluation considers personal values, interests, aspirations, sense of self-worth and managerial skills; and on the other hand, the realities of specific occupational and professional choices. Each

participant will generate and analyze a wide variety of data to provide better insight into his goals, interests, and managerial skills. Greater career fulfillment is the objective. *Prep. 45.816.*

45.824 Organization Behavior in Nonprofit Environment

Human services organizations involved in health care, welfare, and education are studied in reference to recent behavioral theories and concepts dealing with the internal and external complexities and inter-relationships of large-scale organizations. Term projects are designed to conduct and analyze a problem situation and develop plans for implementing change. Readings, cases, and seminars. *Prep. 45.815, 45.816.*

45.828 Seminar in Growth Strategies for Corporate Management

An opportunity for in-depth research and analysis of growth strategies available to business firms. In a seminar setting, students examine firm and industry approaches to growth through expansion and diversification. Special emphasis is placed on the use of research and acquisition as means for achieving growth objectives. *Prep. 45.825, and permission of the instructor.*

45.829 New Ventures: A Career Choice

This course enables students to examine the nature of entrepreneurship and the appropriateness of self-employment for an individual. The focus is on the decision to own and operate one's own business. Students examine the nature of the values, motivations, goals, and life style required by the entrepreneurial role. Guest speakers, cases, selected readings, and self-assessment exercises help students identify the congruency between their own interests and goals and an entrepreneurial career. The course also offers potential value for prospective loan officers, investment bankers and venture capitalists, CPAs, management consultants and others whose career activities may involve them with entrepreneurs and managers of new ventures or smaller companies. *Prep. 15 Q.H. of Grad. Credit, or permission of instructor.*

45.830 Formal Planning Systems

Although plans that extend five or more years into the future are no longer a novelty, the formal planning concept itself is still in its infancy. This course focuses on the present-day "state-of-the-art" in planning for both profit and nonprofit organizations of various sizes. Students are expected to develop hypothetical plans based upon their own assessment of economic and other environmental factors. *Prep. 15 Q.H. of Grad. Credit.*

45.833 Operations Management in the Health Care System

This course serves those whose career goals are positions of responsibility in the management of the health care system. The objectives of the course are: 1. to provide a basic understanding of operations management problems existing in the health care system, and 2. to develop decision-making ability to deal effectively with these problems. Topics covered in the course are: the fundamentals of management in the health care system, organizational planning, operations planning and control, utilization of resources, and policy considerations in effective and efficient operation of the health care system. *Prep. 45.805 and 45.806, or permission of instructor.*

45.835 Seminar in Organizational Development

Organizational development is the process of deliberate organizational change that is planned, organization-wide, and managed from the top so as to increase organiza-

tional effectiveness through planned intervention by change agents. This course examines organizational development as an emerging professional discipline, focusing on identifying variables affected by a change program and developing an understanding of methods and techniques. *Prep. 45.817*

45.836 Policy: The Social, Political, Economic, and Legal Environment

Both business and nonbusiness organizations exist in a multifaceted environment of social, political, economic, and legal entities whose influences must be identified and dealt with by a responsive decision-making process. The concept of corporate strategy is developed as a medium in which to achieve these objectives. *Prep. all other required courses.*

45.837 Policy: The Formulation and Implementation of Strategy

A continuation of course #45.836, with emphasis on the formulation and implementation of organizational strategy. Approaches to strategy formulation and implementation in both profit and nonprofit organizations are compared and contrasted. Topics include: organizational structure and behavior, long-range planning, control and motivation systems, information systems, and leadership. All topics are considered within the systems framework of organizational strategy. *Prep. 45.836.*

45.838 Policy Formation in Health Care

A focus on the problem of defining and implementing policy in the health care sector. The various internal and external components of the health care system are analyzed as they relate to policy making and implementation. The course also includes a discussion of nontraditional methods of health care delivery such as neighborhood health care centers and national health insurance. *Prep. 15 Q.H. of Grad. Credit.*

45.839 Women Managers

A systems approach to an emerging type of manager—the woman. An examination in historical perspective of women in the labor force with attention to the changing socio-economic, technological, and legal environments of the business and service community. Problems encountered for businesses and individual men and women, as well as possible changes. Cases, readings, films and an individual project review. *Prep. 15 Q.H. or by permission of the instructor.*

45.841 Public/Private Service Systems

Examines public/private institutional systems involved in providing public goods and services e.g., health care, housing, education, transportation, defense-aerospace-oceanographic, pollution control, law enforcement. The perspective involves the roles of various participants, and the alternative strategies appropriate for particular participants. *Prep. 15 Q.H. or permission of the instructor.*

45.902 Planning and Control of Manufacturing Operations

A study of the problems of managing the flow of materials, operations, and information within an organization in response to, or anticipation of, market demands. The concepts and techniques discussed are applicable in a variety of institutional settings. Topics include: inventory management, demand forecasting, manpower and operations scheduling, project management, and integrated operations control systems. The tone of the course is pragmatic; particular emphasis is on practical evaluation and problems of implementing the analytic methods discussed. *Prep. 45.806 or permission of the instructor.*

45.951 Executive Development

An examination of the executive position in an organization and the personal characteristics and skills which it requires. The course examines the effects of cultural change and shifting mores on motivation and management control, with their implication for developing appropriate organizational relationships. Report writing, oral reports, and leading of group discussions are dominant techniques. Student evaluation is encouraged. *Prep. 15 Q.H. of Grad. Credit.*

45.962 Institutional Environment of Business I

The relationship of the business corporation to various elements in its environment: political, social, economic, scientific, and educational. Developing interactions and mutual responsibilities, with emphasis on initiating and planning, to influence these external institutional relations rather than only to respond to them. Responsibilities of business and of businessmen for community, national, international, and ecological welfare. *Prep. 15 Q.H. of Grad. Credit.*

45.964 Institutional Environment of Business II

Further examination of the relation of business to its environment and the responsibility of the businessman and the firm to external and internal interests in a dynamic and pluralistic system. Emphasis on situations involving conflicting values and personal, organizational, moral, and public interest, with role playing to allow student participation in corporate conflict determination. *Prep. 45.962.*

45.965 Management of Small Business Enterprises

Problems in various beginning stages of management of new small enterprises. Case studies develop analytical approaches for appraising the risks and rewards of potential growth opportunities, as well as operating problems. Problems range from locating, evaluating and financing a small company, to the survival and growth of an established business. Guest speakers relate pertinent business experiences to in-class activities. *Prep. 15 Q.H. of Grad. Credit.*

45.968 Management of New Enterprises

Oriented toward the entrepreneur. Consideration given to locating and evaluating business opportunities introduced by new ideas, product development, licensing, inventions, patents, etc. The organization, start, and growth of a new business or the acquisition of a going concern, including fund raising and related state regulations. *Prep. 15 Q.H. of Grad. Credit.*

45.969 Government and Business

Analysis of the role of government as a regulating force, as well as the nature and impact of government fiscal, economic, and socio-economic policies on the conduct of business. The political and economic philosophies behind greater government participation in the economic structure of the nation as indicated by public-utility, antitrust, labor, and socioeconomic legislation. *Prep. 15 Q.H. of Grad. Credit.*

45.971 Personnel Management

Significant developments of labor relations and employment theory; the principles of personnel management and of management-union relations; policy considerations for the managing of manpower resources; policy impact of current developments in work theory; and resource management. *Prep. 15 Q.H. of Grad. Credit.*

45.972 Labor Relations

Traditional labor policy in relation to management, unions, and the public; management-union relations as joint control over human resources of private and public organizations; history of the labor movement and collective bargaining; work rules and productivity; labor disputes and supplements to negotiations; political and economic power; legal responsibilities of labor and management; management authority and employee discipline; and types of management-union relations. *Prep. 45.971.*

45.973 New Sectors of Collective Bargaining

A focus on new sectors of bargaining: 1. by public employees, including municipal, state, and Federal; 2. by professional associations, including those of teachers, doctors, nurses, and engineers; and in the mainly unorganized sectors; i.e., agriculture, health care industry, and so-called white-collar-service areas. The purpose is to study the variety of patterns emerging in these sectors as a result of the interplay of the following forces: 1. presence or absence of a national labor law or policy; 2. relationship to existing trade union structure and industrial relations system; 3. occupational characteristics and industry or service technology, and 4. productivity and growth. Varying issues in collective bargaining are discussed through cases, readings, and a group term project, and by invited practitioners. *Prep. 15 Q.H. of Grad. Credit.*

45.975 Introduction to Health Care Systems

Health care systems from the administrator's point of view. Subjects include environmental factors, strategic planning, identification and implementation of objectives, and allocation of resources. A seminar format utilizes both text and cases; students are also expected to prepare a research paper which identifies a health care administration problem and proposes a solution. *Prep. 15 Q.H. of Grad. Credit.*

45.976 Workers in the Health Care System

The present health care system in the United States is in the process of major change generated by both the internal and external social, legal, and professional environments. The purpose of this course is to describe and analyze some of the dynamics and complexities of these changes and to consider how these changes affect the workers in the system. In turn, the worker's influence on these changes is studied. The foci are the past, present, and future of major occupation levels and groupings servicing the system, their relationship to each other and to the total system. A major feature of the course is a group research project. Case studies, readings, lectures, and guest speakers are also used. *Prep. 45.815, 45.816.*

45.977 Information Systems for Health Care Facilities

Introduction to the complexities of the quantity and variety of information requirements in the field and the state of the technology capability, as well as an understanding of the system's components through use of this information. Course covers systems information flow and new computer techniques. Cases, readings, and on-site visits. *Prep. 15 Q.H. of Grad. Credit.*

45.985 Management of Research and Development

Some corporations grow more rapidly than their competitors because of better management of their technical programs. This course focuses on the unique problems of R & D management through readings and case studies of the important consider-

ations involved in dealing with scientists and engineers as individuals; planning, organizing, and controlling research; and establishing a climate for research. *Prep. 41.811 and 45.817.*

45.989 Science and Technology: The Challenge to Management

Greater understanding of the growing importance of the results of science and technology on business activity and of the special problems and opportunities encountered by management in using this knowledge. The course examines the complex interaction of social, economic, political, and technical variables affecting the climate for technological change. The critical role of the manager in the innovative process is studied, examining the great array of techniques which help him keep abreast of new R & D results. The contribution of various organizational structures to the creative application of technology is also examined. *Prep. 15 Q.H. of Grad. Credit.*

45.991 Business Law—Law of Contracts, Agency, and Sales

Designed to give the student a basic knowledge of the legal aspects of contracts and the results of contractual obligations. Attention is paid to the employment contract in general, with emphasis on the principal and agent, and the master and servant relationships. The law governing the sale of personal property as reflected in the Uniform Commercial Code is incorporated. *Prep. 15 Q.H. of Grad. Credit.*

45.992 The Law of Business Organizations and Negotiable Instruments

The Law of Negotiable Instruments as reflected in the Uniform Commercial Code, with special consideration given to commercial paper used in business transactions. The law governing formation and operation of partnerships, corporations, and other business organizations, with emphasis on the legal results and operations of those concerned with the liability of members thereof. A study of the legal framework within which the formal business organization must operate. *Prep. 45.991 and 15 Q.H. of Grad. Credit.*

45.993 Labor Law

An overview of constitutional and legal problems involved in labor organizing, industrial relations, labor negotiations, labor contract enforcement, and dispute resolution in both private and public sectors of labor administration. Cases are studied for the legal principles underlying common law, state and federal laws, and constitutional questions of power and authority. *Prep. 15 Q.H. Grad. Credit.*

45.997 Special Studies in Business Administration (1 to 3 Q.H. Credit)

A special tutorial arrangement between a student and a faculty member for a guided reading, research, laboratory, fieldwork, report, or teaching experience. It is for graduate students who desire to do advanced work or carry out some special investigation of a problem in business administration not specifically covered elsewhere in the curriculum. Students must petition the Committee on Graduate Study in Business Administration for permission to register in this course. This petition should include an outline, a brief description of the work planned, and an indication of the professor to whom the student will be responsible. The professor will submit to the Graduate Office a letter outlining in some detail the nature of the work that the student will be doing in the course. The petition will be submitted after the student has received permission to take the course from a member of the College of Business Administration faculty. The course carries variable credit, ranging from one to three quarter hours. *Prep. 15 Q.H. of Grad. Credit.*

45.998 Special Studies in Business Administration (3 Q.H. Credit)

See 45.997 for course description.

45.999 Special Studies in Business Administration (3 Q.H. Credit)

See 45.997 for course description.

48.801 Seminar in Transportation

The objectives are twofold: 1. to provide a basic understanding of the functions and importance of the domestic transportation system, and 2. to develop the student's ability to analyze government policies related to transportation. The cost, service, and pricing characteristics of the several modes of transportation are examined. Emphasis is given to the special problems which confront both carriers engaged in the various forms of transportation and shippers who rely upon their services. *Prep. 15 Q.H. of Grad. Credit.*

48.801 Physical Distribution Management

Study of the design and management of physical distribution systems to facilitate the flow of goods through distribution channels. It covers aspects of plant and warehouse locations, inventory controls, and selection of transportation carrier. The course includes the use of case problems in logistics. *Prep. 15 Q.H. of Grad. Credit.*

49.901 Managerial Economic Analysis

Managerial economic analysis establishes the economic foundations and framework for managerial decisions. The course provides an introduction to the principles of economic analysis, economic institutions, and issues of public policy. It stresses the interdependency of the economic decisions of the firm with industry structures and national economic policies. Topics covered include: sources, market decisions and market structure, employment and growth, and the economic role of governmental resource allocations. *Prep. none.*

49.902 Quantitative Analysis I

Decision making takes place in a probabilistic environment. The concept of statistical inference is emphasized, with the objective of generating and understanding the process by which the analyst draws conclusions from a small sample compared to the characteristics of a large data set. The techniques employed in decision making under uncertainty (payoff tables, decision trees) are also discussed. *Prep. None.*

49.903 Quantitative Analysis II

Introduction to the theory and practice of management science and operations research. The topics of regression analysis, linear programming, and simulation are discussed in text and case material; emphasis is on practical application of these techniques. Issues of problem definition, model building, relevant cost determination, solution generation, and implementation of results are considered. *Prep. 49.902.*

49.907 Operations Management Game

The Operations Management Game is a computer game of considerable complexity focusing on operations problems. Teams are formed to make several decisions affecting the operation of the firm for the next day: i.e., on hiring-firing, overtime, machine sequencing, maintenance, and capital expenditures. These decisions are then submitted to the computer and their consequences are provided as output to each team. The team reacts by preparing another set of entries to guide the firm's operation for the next day. During the game models covered in operations research

and the operations management courses are explored to determine their usefulness as decision aids. *Prep. 49.903, 45.806.*

49.918 Information Theory and Systems

The objective of this course is to develop a framework for the analysis of communication and information systems in organizations. Aspects of communications theory are studied as background for building this framework and its underlying theory is tested. Topics include development of an analytical framework for viewing information systems and communication in organizations. Various aspects of communications theory are discussed and analyzed. A major objective of the communications and informations flow in organizations is to tie these events back to the underlying theory. *Prep. 15 Q.H. of Grad. Credit.*

49.932 Introduction to Computer Applications

A business-oriented introduction to data processing functions and systems. Introduction to the history, terminology, technology, and economics of data processing hardware and software. Management issues in the design, selection, evaluation, and use of computers and computer services. Individual familiarization with elementary computer programming by using either batch or time-shared computer facilities to solve simple business-oriented exercises. When feasible, a visit to a data processing center is conducted. *Prep. 15 Q.H. of Grad. Credit or permission of the instructor.*

49.933 The Computer and Its Applications II

The Management Information System (MIS) concept which stresses how a computer-powered information system can benefit all levels of management is emphasized. The course illustrates the economics of MIS and computers, describing the steps necessary for successful installation and employment of MIS concepts. An extensive case study illustrates systems design, dollar/benefit tradeoffs, and the proper level of management involvement. Familiarization with the systematic or systems approach to analyzing and solving computer and information systems problems as well as general business problems. Business management rather than computer technology is stressed. *Prep. 49.932.*

49.935 Computer Applications in Management Science

Discussion of the technical, economic, and procedural aspects of applying quantitative techniques of management science to planning and operations problems. Heavy emphasis is on the computer's role in this process. Concentration is on selected techniques such as linear programming, simulation, and multiple regression analysis. Practical problems of designing computer programs, selecting canned packages, gathering data, and implementing results are considered. The required term project allows an in-depth study of an area and/or technique of the student's choosing. This project may take a variety of forms: a computer model written by the student, use of a canned package or a model written by others, library research report, formulation of a practical problem for future solution. Ability to program is not required, nor is computer programming emphasized; however, extensive time-sharing and batch-processing computer service is available for those who wish to use it. *Prep. 49.902, 49.903, and 49.932.*

undergraduate universities attended by students

Air Force Academy	Lehigh University
Amherst College	Lowell Technical Institute
Arizona, University of	Loyola University (Chicago)
Assumption College	Maine, University of
Bates College	Maryland, University of
Bentley College	Massachusetts Institute of Technology
Boston College	Massachusetts Maritime Academy
Boston University	Massachusetts, University of
Bowdoin College	McGill University (Canada)
Brandeis University	McMaster University (Canada)
Bridgeport, University of	Merrimack College
Brooklyn Polytechnic Institute	Nebraska, University of
Brown University	New Hampshire, University of
Bucknell University	Northeastern University
Calcutta, University of (India)	Notre Dame, University of
California, University of	Ohio Wesleyan University
Canisius College	Pennsylvania State University
Case Institute of Technology	Pennsylvania, University of
Catholic University of America	Plymouth State College
Catholic University (Venezuela)	Providence College
Cincinnati, University of	Radcliffe College
City College of New York	Rensselaer Polytechnic Institute
Colby College	Rhode Island, University of
Colgate University	Rochester Institute of Technology
Columbia University	Rochester, University of
Connecticut, University of	Rutgers, The State University (New Jersey)
Cornell University	St. Anselm's College
Dartmouth College	St. John University
Delaware, University of	St. Lawrence University
Denison University	Simmons College
Drake University	Smith College
Drexel University	Stanford University
Duke University	State College at Boston
Fairfield University	State University of New York, at Buffalo
Florida, University of	State University of New York, at Genesee
Fordham University	State University of New York, at Oneonta
Franklin and Marshall College	Stonehill College
Fayetteburg College	Suffolk University
Hartford University	Sydenham College (India)
Harvard University	Syracuse University
Hawaii, University of	Tennessee, University of
Hiram College	Texas, University of
Hobart College	Tufts University
Hofstra University	United States Merchant Marine Academy
Holy Cross College	United States Military Academy
Houston, University of	United States Naval Academy
Illinois, University of	Vermont, University of
Institute of Science (India)	Villanova University
Ithaca College	Virginia Polytechnic Institute
Johns Hopkins University	Wesleyan University
Lafayette College	Worcester Polytechnic Institute
Lake Forest College	Yale University

faculty directory

<i>Name</i>	<i>Room</i>	<i>Extension</i>
Ammer, Dean S.	213 HA	437-3252
Anderson, Harley H.	202 HA	3230
Arnett, Matthew D.	305 HA	3257
Caplan, Robert H.	302 HA	3255
Carter, Clairmont P.	205 HA	3240
Castellano, John J.	213 HA	3252
Cerullo, Saverio	209 HA	3248
Chugh, Lal C.	209 HA	3248
Collazzo, Charles J.	322 HA	3260
Croke, Paul V.	305 HA	3257
Crotty, Philip T.	202 HA	3230
Curran, Joseph R.	213 HA	3252
Dufton, Charles H.	322 HA	3260
Farrar, Robert H.	205 HA	3240
Fetters, Michael	205 HA	3240
Fiumara, Angelo	204 HA	3236
Godin, Victor B.	204 HA	3236
Graetz, Herbert	305 HA	3257
Gubellini, Carlo E.	206 HA	3244
Hehre, Robert J.	222 HA	3248
Hekimian, James S.	202 HA	3230
Higgins, Richard B.	304 HA	3255
Hobart, Christine L.	213 HA	3252
Janell, Paul	205 HA	3240
Jordan, John W.	224 HA	2714
Keith, Lyman A.	204 HA	3236
Kinnunen, Raymond A.	302 HA	3255
Lieb, Robert	204 HA	3236
Lindhe, Richard	205 HA	3240
Malchman, Lawrence	114 HA	2167
Marple, Wesley W.	209 HA	3248
Marshall, Edward	213 HA	3252
McCarthy, Daniel J.	302 HA	3255
McDonald, Philip R.	322 HA	3260
Minichiello, Robert J.	322 HA	3260
Moriarty, Mark M.	322 HA	3260
Nielson, Richard	322 HA	3260
Olive, Russell W.	302 HA	3255
Parsons, Robert A.	302 HA	3255
Priem, Andre P.	305 HA	3257
Richards, Paul C.	205 HA	3240
Rochwarg, Herman	305 HA	3257
Rugina, Anghel N.	209 HA	3248
Santos, Richard J.	212 HA	3272
Scioletti, Daniel C.	204 HA	3236
Shelley, Charles	204 HA	3236
Slavin, Albert	205 HA	3240
Stephenson, Frederick J.	204 HA	3236
Timmons, Jeffry	213 HA	3252
Ward, Raymond	209 HA	3248
Willett, Edward	209 HA	3248
Wiseman, Frederick	322 HA	3260

index

A

Academic Council, 13
Academic Requirements, 28
Address of University, 1
Administration
 University, 11
 Graduate Division, 14, 15
Application Procedure and
 Admission Requirements, 27, 29
Assistantship, 26

B

Board of Trustees, 9
Buildings and Facilities, 22
Brockton Campus, 24
Burlington Campus, 23

C

Calendar, 64
Campus Description and Location, 22
 Map, 64
Changes in Requirements, 29
Class Hours, 30
Classifications, Academic, 29
Colleges, Undergraduate, 61
Committee on Graduate Study in
 Business Administration, 18
Committees, General University, 13
Continuing Education, Center for, 20
Continuity of Program, 29
Cooperative Plan of Education, 19
Corporation, 7
Courses, Description of, 47
Credits, 30
 Transfer, 31
Curriculum, 41
Contents, 3

D

Degree, Application for, 29
Degree Requirements, 28
Dormitory Proctorships, 34

E

Elective Courses, 42, 43
Executive Council, 13

F

Faculty, 37
Faculty Directory, 62
Faculty Senate, 14
Fellowships, 35
Financial Information, 33
Full-Time Program, 25
Framingham Campus, 24

G

Grading System, 30
Graduate and Professional Schools, 19
Guaranteed Student Loan Program, 34

H

Henderson House, 24
Holidays, 5

I

Internship, 25

L

Libraries, 22
Living Accommodations, 23
Loans, 34, 35

M

Map of Campus, 64
Marine Science Institute, 24

N

National Direct Student Loan, 35
Nashua Campus, 24

P

Part-time Recommended Program, 27
Program for Advanced Study in
 Business Administration, 45
Programs, types of, 25
 Part-Time, 27
 Full-Time, 25, 27

R

Refunds, 34
Registration, 31
Regulations, 28
Research Activities, 20
Residence, Academic, 31
 Facilities, 23
Required Courses, 41

S

Schools, Graduate and Professional, 19
Sloan Scholarship Program
 for Minority Students, 35
Student Center, 22
Suburban Facilities, 23

T

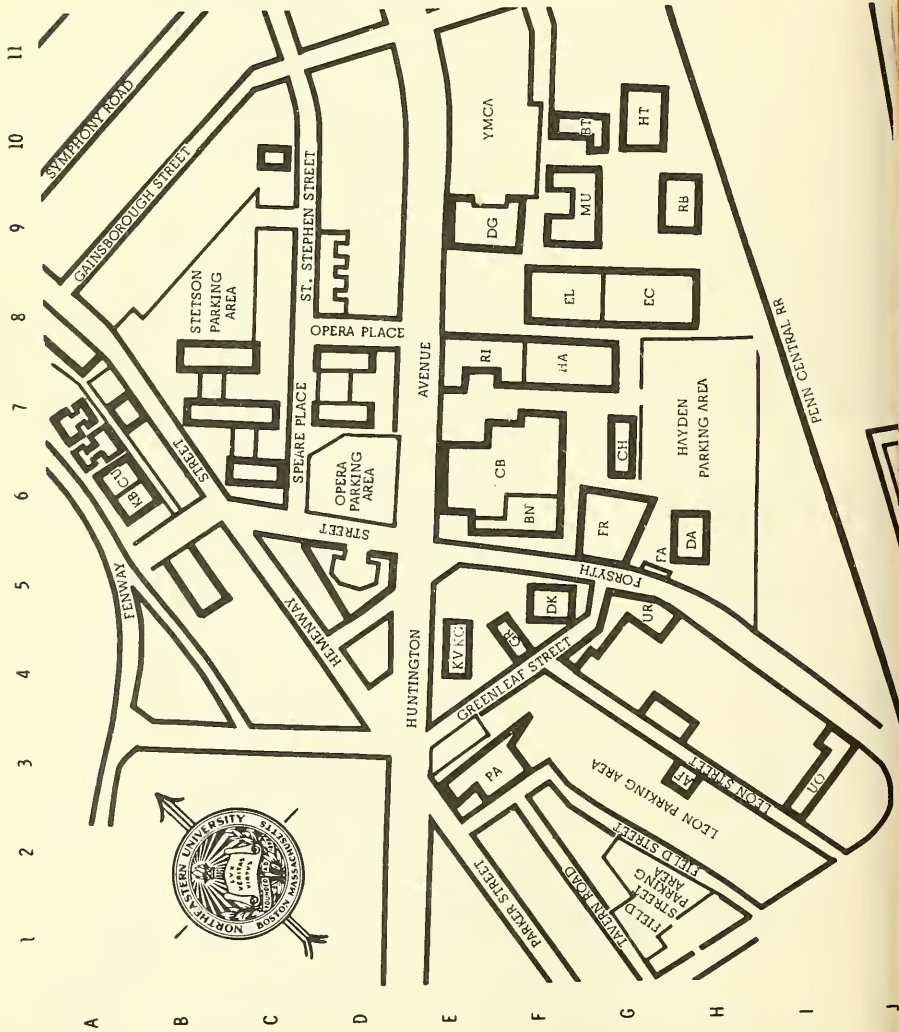
Time Limits, 31
Transfer Credit, 31
Trustees, 9
Tuition, 33

U

Undergraduate Universities Attended
 by Students, 61
University Council, 13
University, Description of, 19
University Graduate Council, 15

W

Waiver Procedure, 31
Warren Center, 23
Withdrawals, 32



**MAP
REFERENCE**

- F6
F10
E6
G7
A6
H6
F5
E9
G8
F8
G6
G5
F4
F7
G10
B6
E4
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J3
H3
F9
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E7
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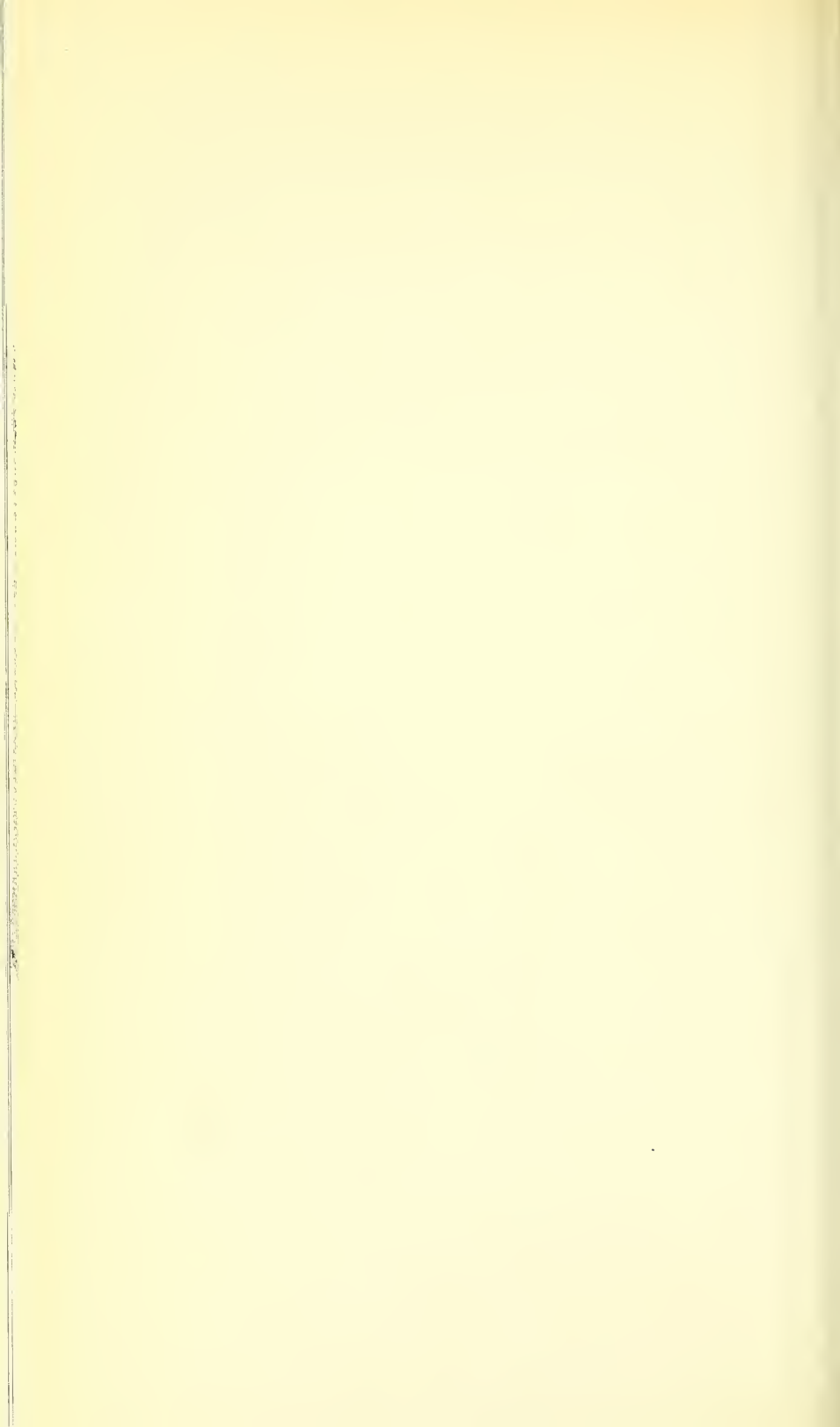
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Cushing Hall
Dana Research Center
Dockser Hall
Dodge Library
Ell Student Center and
Alumni Auditorium
Forsyth Building
Forsyth Building Annex
Greenleaf Building
Hayden Hall
Hurting Hall
Kennedy Building
Knowles Center (Volpe)
Knowles Center (Gryzmish)
11 Leon Street
Afr-American Institute
Mugar Life Sciences Building
Parker Building
Richards Hall
Robinson Hall
United Realty Building

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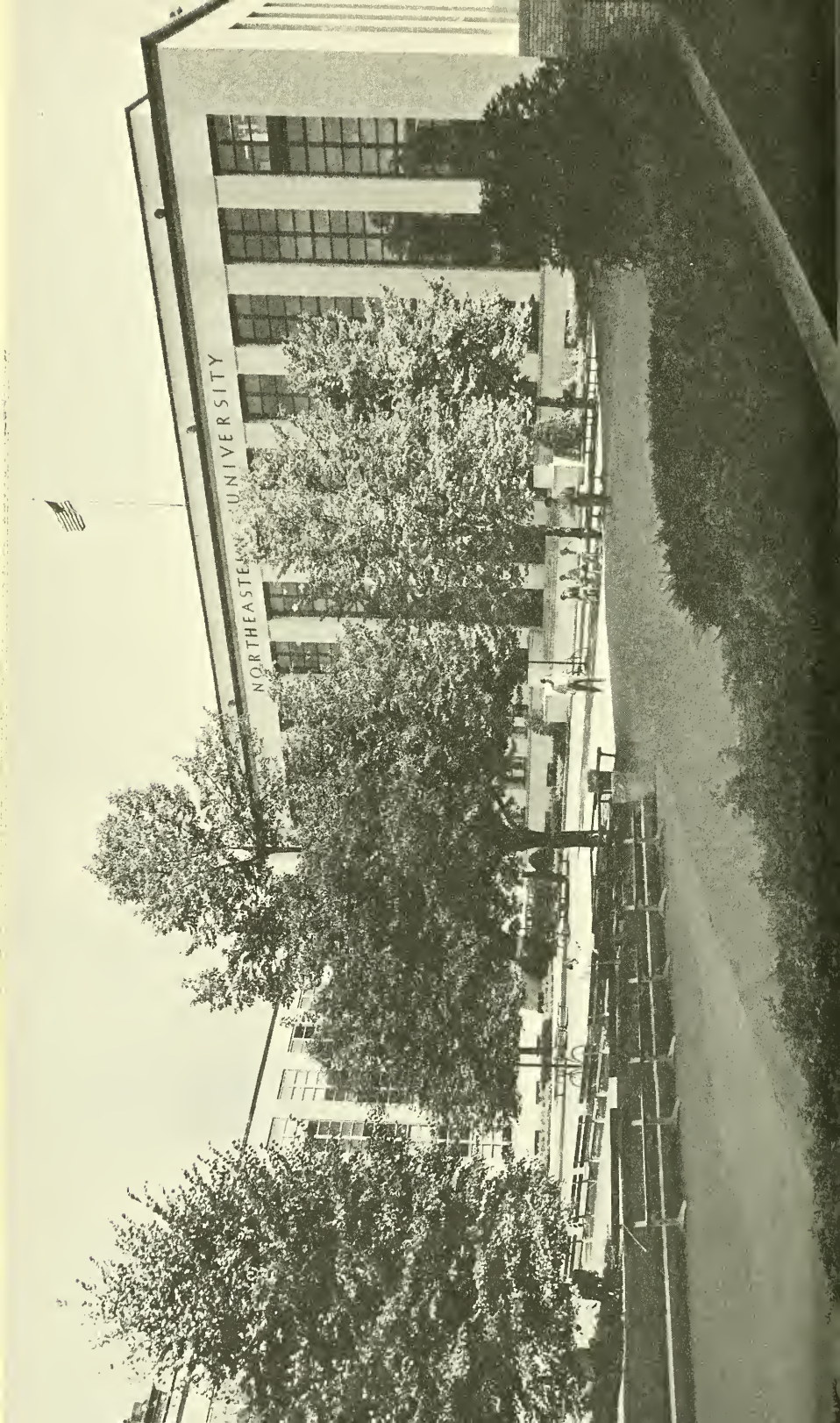
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AND COLLEGES
FOUNDED IN 1884

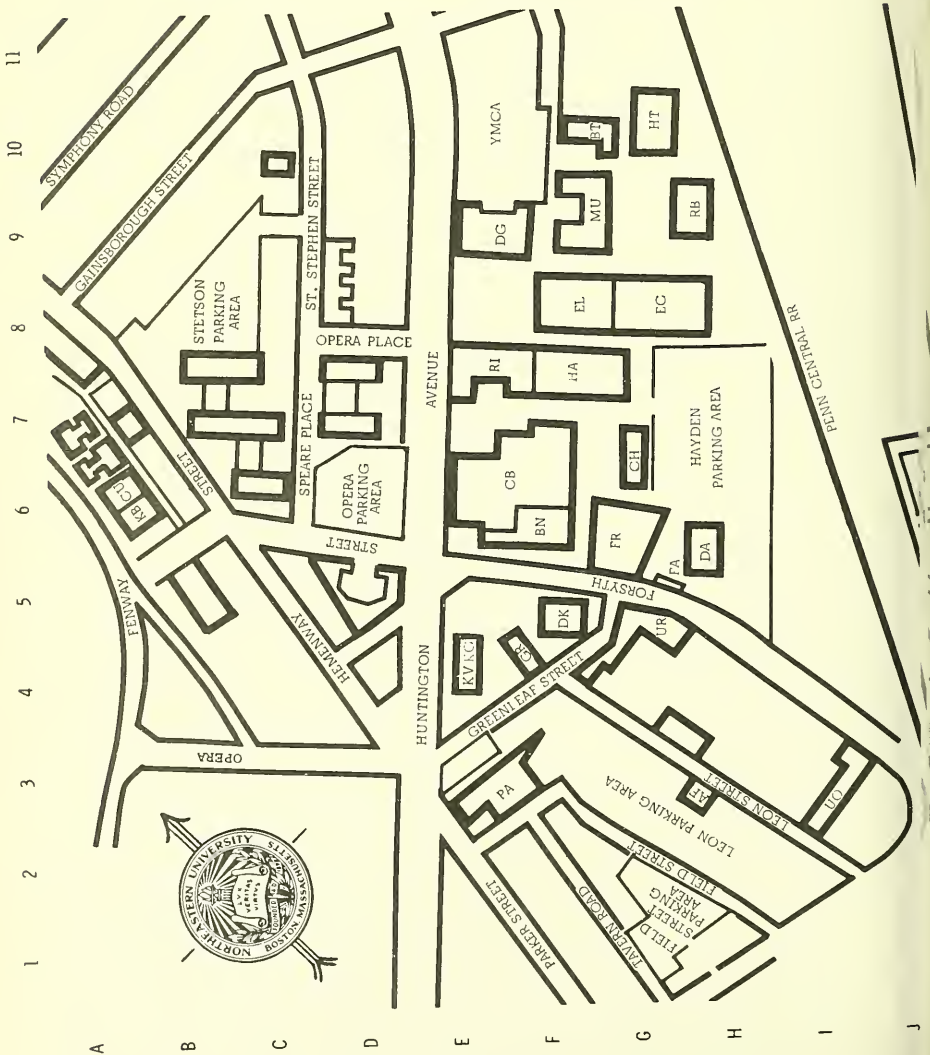
Northeastern University
144 Knowles-Volpe
360 Huntington Avenue
Boston, Massachusetts 02115
Telephone (617) 437-3327

Graduate Program in Criminal Justice 1974-75



contents

4	Campus Map
5	Academic Calendar
6	University Holidays
7	The Governing Boards and Officers of the University
7	Corporation
9	Board of Trustees
11	Administrative Organization
13	General University Committees
14	Organization of the Graduate Schools
19	The University
22	Buildings and Facilities
25	College of Criminal Justice Graduate Program
26	Part-Time Study
26	General Regulations
28	The Master of Science Degree
33	Financial Information
33	Financial Obligations
34	Financial Aid
37	Faculty
38	Fields of Study
38	Programs in Professional Specializations
40	Model Program
41	Specimen Programs
44	Courses
48	Index



MAP
REFERENCE

- F6
F10
E6
G7
A6
H6
F5
E9
G8
F8
G6
G5
F4
F7
G10
B6
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Building

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ACADEMIC CALENDAR 1974-1975

Fall Quarter 1974

Registration period (1:00-3:00 and 5:30-8:00 p.m.)		
Boston	Monday-Thursday	Sept. 23-Sept. 26
Classes begin	Monday	September 30
Thesis committee approval forms due (full-time students)	Friday	November 15
Last day to drop a course	Wednesday	November 27
Examination period*	Monday-Friday	Dec. 16-Dec. 20

Winter Quarter 1974-1975

Registration period (1:00-3:00 and 5:30-8:00 p.m.)		
Boston	Monday-Thursday	Dec. 9-Dec. 12
Approved thesis proposals due (full-time students)	Monday	December 16
Classes begin	Monday	January 6
Last day to drop a course	Saturday	March 8
Examination period*	Monday-Friday	Mar. 24-Mar. 28

Spring Quarter 1975

Registration period (1:00-3:00 and 5:30-8:00 p.m.)		
Boston	Monday-Thursday	Mar. 17-Mar. 20
Classes begin	Monday	April 7
Last day to drop a course	Saturday	June 7
Examination period*	Monday-Friday	June 16-June 20

Summer Quarter 1975

Registration period (1:00-3:00 and 5:30-8:00 p.m.)		
Boston	Wednesday-Thursday	June 18-June 19
Classes begin	Monday	June 30
Last day to file commencement card for fall commencement	Friday	August 1
Thesis due (full-time students)	Monday	August 11
Last day to pay fee for fall commencement	Friday	August 29
Fall commencement	Thursday	Sept. 11

*Examinations for day classes will be held in accordance with the undergraduate examination schedule.

UNIVERSITY HOLIDAYS 1974-1975

Columbus Day	Monday	October 14
Veterans' Day	Monday	October 28
Thanksgiving Recess	Thursday-Saturday	Nov. 28-Nov. 30
Christmas Vacation	Monday-Friday	Dec. 23-Jan. 3
Washington's Birthday	Monday	February 18
Patriots' Day	Monday	April 15
Memorial Day	Monday	May 27
Independence Day	Thursday	July 4
Labor Day	Monday	September 2

Equal Opportunity Policy

Northeastern University is committed to a policy of providing equal opportunity for all. In all matters involving admission, registration, and all official relationships with students, including evaluation of academic performance, the University insists on a policy of nondiscrimination. Northeastern University is also an equal opportunity employer; it is institutional policy that there shall not be any discrimination against any employee or applicant for employment because of race, color, religion, sex, age or national origin. In addition, Northeastern takes affirmative action in the recruitment of students and employees.

the governing boards and officers of the university

THE CORPORATION

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the university

Founded in 1898, Northeastern University is incorporated as a privately endowed nonsectarian institution of higher learning under the General Laws of Massachusetts. The State Legislature by special enactment has given the University general degree-granting powers. The University is governed by a Board of Trustees elected by and from the Northeastern University Corporation, which is composed of 170 distinguished business and professional men and women.

From its beginning, Northeastern University has had as its dominant purpose the discovery of community educational needs and the meeting of these in distinctive and serviceable ways. The University has not duplicated the programs of other institutions, but has sought to pioneer new areas of educational service.

A distinctive feature of Northeastern University is its Cooperative Plan, initiated by the College of Engineering in 1909 and subsequently adopted by the Colleges of Business Administration (1922), Liberal Arts (1935), Education (1953), Pharmacy (1962), Nursing (1964), Boston-Bouvé College (1964); the College of Criminal Justice (1967); and by Lincoln College's daytime Bachelor of Engineering Technology program (1971). This educational method enables students to gain valuable practical experience as an integral part of their college program and also provides the means by which they may contribute substantially to the financing of their education. The Plan has been extended to the graduate level in engineering, actuarial science, rehabilitation administration, professional accounting, business administration, and law.

In the field of adult education, programs of study have been developed to meet a variety of needs. University College offers evening courses — offered by the University since 1906 — and adult-day courses leading to the bachelor's degree. In addition to offering day undergraduate programs in Electrical Engineering Technology and Mechanical Engineering Technology, Lincoln College offers evening/part-time certificate, associate, and bachelor degree programs in technological areas. All formal courses of study leading to degrees through part-time programs are approved by the Basic College faculties concerned.

GRADUATE AND PROFESSIONAL SCHOOLS

The ten graduate and professional schools of the University offer day and evening programs leading to the degrees listed.

The Graduate School of Actuarial Science offers the degree of Master of Science in Actuarial Science.

The Graduate School of Arts and Sciences offers the degrees of Master of Arts, Master of Science, Master of Science in Health Science, Master of Public Administration, and Doctor of Philosophy.

The Graduate School of Boston-Bouvé College offers the degree of Master of Science.

The Graduate School of Business Administration offers the degree of Master of Business Administration.

The Graduate Program in Criminal Justice offers the degree of Master of Science.

The Graduate School of Education offers the degree of Master of Education and the Certificate of Advanced Graduate Study.

The Graduate School of Engineering offers the degrees of Master of Science, Engineer degree, Doctor of Engineering, and Doctor of Philosophy.

The School of Law offers the degree of Juris Doctor.

The Graduate School of Pharmacy and Allied Health Professions offers the degrees of Master of Science and Doctor of Philosophy.

The Graduate School of Professional Accounting offers the degree of Master of Science in Accounting.

CENTER FOR CONTINUING EDUCATION

The Center for Continuing Education was established in 1960 to relate the University to the needs of its community in a period of accelerated change. Adult education programs offered by the Center and University College have since been consolidated. Its programs are composed of seminars, conferences, institutes, forums, and a wide variety of special courses designed to serve specific needs. The Division of Special Programs, working cooperatively with trade associations and professional societies, offers a wide variety of programs dealing with current needs and problems. Through its Division of Community Services, working with governmental agencies and community organizations, the Center is becoming increasingly involved in social problems on both the local and national level.

Many of these programs are conducted at Henderson House, Northeastern University's conference center in Weston, Massachusetts.

RESEARCH ACTIVITIES

The facilities of the University are engaged in a wide variety of basic research projects in business, science, social science, pharmacy, and engineering. These are coordinated by the Dean of

Research, whose services are University-wide and available to the faculties of all the Colleges.

Although Northeastern is primarily concerned with undergraduate and graduate instruction, the University believes that the most effective teaching and learning take place in an environment characterized by research activities directed toward extending the frontiers of knowledge.



buildings and facilities

MAIN CAMPUS

The main campus of Northeastern University is located at 360 Huntington Avenue in the Back Bay section of Boston. Many of the city's famous cultural, educational, and philanthropic institutions are situated in the Back Bay, including the Museum of Fine Arts, Symphony Hall, Horticultural Hall, the Isabella Stewart Gardner Museum, the Harvard teaching hospitals, the Boston Public Library, and many schools and colleges. Most are within walking distance of Northeastern University.

Major transportation facilities serving the Boston area are Logan International Airport, two rail terminals, bus terminals serving inter- and intrastate lines, and MBTA subway-bus service within the metropolitan-suburban area. There is a subway stop in front of the campus. For motorists, the best routes to the campus are the Massachusetts Turnpike (Exit 22) and Route 9, of which Huntington Avenue is the intown section.

The campus of 48 acres is divided by Huntington Avenue, with the main educational buildings on one side and dormitories on the other. The principal buildings, all of which have been constructed since 1938, are of glazed brick in contemporary classic style. Most are interconnected by underground passageways.

Ell Student Center

The Carl S. Ell Student Center provides facilities for student recreation and for extracurricular activities. The Alumni Auditorium, with a seating capacity of 1,300, is part of the Center. Also included are special drama facilities, a ballroom main lounge, fine arts exhibition area, student offices, conference rooms, and a dining area seating more than 1,000.

Libraries

The University library system consists of the Dodge Library, which is the main library; the Suburban Campus Library at Burlington; the School of Law Library; and divisional libraries for Physics and Electrical Engineering, Chemistry and Biology, Mathematics and Psychology, and Health, Physical and Recreation Education, and Physical Therapy. There are additional subject collections for the Center for Management Development at Andover, Massachusetts, and the Marine Science Institute in Nahant.

The library collections number 360,000 volumes supplemented by some 267,000 titles in microprint, microfilm, and microfiche forms. The collection includes, in addition, some 3,500 periodical titles, 90,000 documents, and 4,600 sound recordings.

Cabot Physical Education Center

The Godfrey Lowell Cabot Physical Education Center is one of the best equipped in New England. The large gymnasium contains four basketball courts. In addition, the Center consists of an athletic cage, a small gymnasium, and a rifle range, as well as administrative offices for the Department of Athletics and for the Physical Education Department of Boston-Bouvé College.

A recent addition to the center, the Barletta Natatorium, houses a 105-foot swimming pool, a practice tank for the crew, handball courts, and shower and dressing facilities.

Dockser Hall

Charles and Estelle Dockser Hall, completed in 1968, houses a large gymnasium, dance studio, motor performance laboratory, college library, community recreation laboratory, folk arts center, dark and music rooms, recreation resources area, locker rooms, offices, classrooms, conference room and lounge, storage facilities, and a research laboratory.

Apartments for Graduate Students

The University maintains a 100-apartment housing unit which accommodates 279 people. Two-, three-, and four-party apartments are available which vary in size from two to four rooms plus bath. Apartments are furnished with beds, chairs, desks, stove, refrigerator, and kitchen table. The cost includes all utilities.

A \$50 deposit is required when making application for the apartments. Applications are available in the Office of University Housing. Students are expected to make such arrangements on a term-to-term basis but may live in the apartments both while on cooperative work assignments and in school if they wish. All reservations are made on a first come, first served basis.

SUBURBAN FACILITIES

Suburban Campus

The Suburban Campus, located near the junction of Routes 128 and 3 in Burlington, Massachusetts, was established to meet the needs of individuals and of industry in the area.

In addition to graduate courses in engineering, physics, mathematics, business administration, science, education, and the arts,

portions of undergraduate programs leading to the associate and bachelor's degrees, special programs for adults, and noncredit state-of-the-art programs are offered.

Warren Center

The Warren Center is a practical laboratory for Boston-Bouvé College in outdoor education and conservation, in group practicum, and in camping administration, programming, and counseling. At this Center in Ashland, completed in 1967, there are tennis courts, field hockey and lacrosse fields, waterfront for swimming and boating, overnight camp sites, fields and forests, heated cottages, the Hayden Lodge with a recreation hall, library, crafts shop, dining facilities, and conference accommodations.

Henderson House

The University's conference center, Henderson House, is located in Weston, Massachusetts. The Center for Continuing Education conducts short-term courses, seminars, and special institutes for business, professional, and research groups. Henderson House is 12 miles from the main campus.

Marine Science Institute

The Marine Science Institute at Nahant, Massachusetts, is a research and instructional facility primarily engaged in studies of marine biology and oceanography. The Institute is operated all year, and is about 20 miles northeast of Boston. Many of the courses at this institute are applicable toward an advanced degree in biology or health science.

Brockton, Nashua, and Framingham Campuses

For students residing in southeastern Massachusetts and northeastern Rhode Island, the Graduate School of Business Administration offers a major portion of its M.B.A. Program at facilities in Brockton, Massachusetts. These facilities, made available by the Veterans Administration Hospital, are conveniently located just off Route 24.

Students residing in the southern New Hampshire area may take a major portion of the M.B.A. Program at facilities in Nashua, New Hampshire. These facilities are furnished by Sanders Associates, Inc. and are located in their headquarters on Route 3, just over the Massachusetts line.

For students in the Framingham-Worcester area, a major portion of the M.B.A. Program may be taken at classroom facilities located in Framingham, Massachusetts.

college of criminal justice graduate program

The Graduate Program in Criminal Justice at Northeastern University offers both a full- and part-time program leading to a Master of Science degree. Students have the opportunity to choose among three major concentrations of study: administration, policy development, and planning; behavioral science theory; and research. Development of leadership qualities is stressed in each specialization. The purpose of the graduate program is to provide innovative concepts in academic study and research of crime using the criminal justice process.

The master's program in criminal justice concentrates on the problem of crime as a form of deviant behavior through a system established in response to that problem. The multidisciplinary academic program emphasizes a systems approach to criminal justice, and stresses organizational and management theory. Broad in concept, the program is to be understood as encompassing such related disciplines as law, sociology, political science, psychology, criminology, and public administration. Its primary educational function is to prepare individuals for research, teaching, and administration within a changing criminal justice system.

Faculty members represent several academic disciplines. Teaching activities vary in nature and depend on the instructor's specific objectives. Specialized areas include courses in community treatment, delinquency, correctional management, criminology, and criminalistics.

The goals of graduate study in the College of Criminal Justice are:

1. To develop leaders capable of assuming responsibility for policy planning, administration, and group leadership.
2. To prepare individuals for criminal justice teaching positions in community colleges and other educational institutions.
3. To provide students with the necessary skills and knowledge for applied research and facilitate their ability to discern problem areas.
4. To provide a foundation for advanced doctoral study.

FULL-TIME STUDY

Graduate study in criminal justice may be pursued through either a full- or part-time program. Full-time study allows for completion of course work within one academic year, beginning in September and ending in June of the following year. A substantial portion of the full-time student's time is devoted to academic study; however, simultaneous work on the thesis is expected during this period. Most students finish the thesis requirement in one additional quarter, thereby completing the program within one calendar year.

PART-TIME STUDY

Graduate study is also possible on a part-time basis. The part-time student is allowed to carry a maximum of two courses per quarter. Close consultation with a faculty adviser helps the part-time student determine a workable sequence of courses, and decide the number of credits to be carried each quarter. All degree requirements must be completed within five years from the date of enrollment.

GENERAL REGULATIONS

The general regulations and minimum requirements for all graduate programs are established by the Northeastern University Graduate Council. In some matters the committee of each graduate school is allowed discretion to establish regulations within limits defined by the Council. The regulations and academic requirements which follow have been formulated in accordance with this general policy.

Application

All applicants should address inquiries to the Graduate Program of Criminal Justice. Application forms and information will be mailed promptly.

Registration

Students must register within the period listed on the school calendar. Registration is not permitted after this period.

Residence

All work for advanced degrees must be completed in residence at the University, unless approval has been obtained from the Director of the Graduate Program of Criminal Justice for work taken elsewhere. Students who are in residence and using the facilities of the University must register for such work.

Grading System

The performance of students in graduate courses is recorded by the instructor, using the following grades:

- A Excellent
For performance of high graduate caliber
- B Satisfactory
For performance at a satisfactory level
- C Fair
For performance not at the level expected in graduate work
- F Failure
For unsatisfactory performance
- I Incomplete
For failure to complete course work

The designation I will be changed to a grade upon removal of the deficiencies which caused the I to be reported. Deficiencies must be removed within a period stipulated by the professor.

Any student who wishes to take a make-up examination must obtain permission from the professor teaching the course. A reasonable time period for the examination is discussed and set by the professor.

Class Hours and Credits

All credits at Northeastern University are entered as quarter-hour credits, with a quarter hour of credit being equivalent to three-fourths of a semester hour: i.e., 12 semester hours are equal to 16 quarter hours.

All classes in the Graduate Program in Criminal Justice meet on a quarter basis, with an academic quarter defined as a term of approximately 12 weeks' duration. The academic calendar in the front of this bulletin should be consulted to determine the opening dates of each quarter.

Continuity of Program

Students are expected to maintain continuous progress toward a degree. Any student who does not attend Northeastern for a period of one year must apply for readmission.

Withdrawals

In order to withdraw from a course, a student must fill out an official withdrawal form obtained at the Registrar's Office. Withdrawals may be made through the ninth class meeting of the quarter. Students will be withdrawn as of the date on which they complete

the form. Ceasing to attend a class or notifying the instructor does not constitute an official withdrawal. Petitions for withdrawal from a course after the ninth class meeting of the quarter must be submitted to the Director of the Graduate Program, and may be approved to avert unusual hardships on the student.

Students who do not attend the first two sessions will be dropped from the class unless they notify the Registrar of their intention to continue.

Changes in Requirements

The continuing development of the Graduate Program requires occasional revision of curricula. In every new bulletin, some improvements are indicated. When changes impose no hardships on the student and school facilities permit, the student is expected to meet the requirements of the latest bulletin. If the student finds it impossible to meet these requirements, the bulletin for the year in which he entered becomes the binding one.

Application for the Diploma

If a commencement card is not filed with the Registrar's Office on or before the applicable date listed on the calendar, there is no assurance that the degree will be granted in that particular year, even though all other requirements have been fulfilled.

THE MASTER OF SCIENCE DEGREE

Admission Requirements for Degree Candidacy

All applications for graduate study in Criminal Justice are reviewed by the Graduate Admissions Committee, and must include:

1. A completed application accompanied by a nonrefundable \$15 application fee.
2. Official transcript(s) from accredited institution(s) as evidence of earning a baccalaureate degree with a gradepoint average of approximately 3.0 or higher.
3. Official scores from the aptitude test of the Graduate Record Examination or Law School Aptitude Test; above-average scores are preferred.
4. Three letters of recommendation from academic, professional, or personal sources; academic references are preferred.
5. An essay of not more than 400 words which expresses academic and personal objectives.

No one factor is used to select candidates for the program. The Graduate Admissions Committee receives all applications and considers a variety of factors including previous work experience and professional potential, in addition to academic record and test

scores. When possible, students are asked to participate in an admissions interview to help the Committee make a complete evaluation.

Consideration for admission is given only after all application material, including the \$15 application fee, has been received by the Graduate Program in Criminal Justice.

Student Classifications

Students whose credentials meet the criteria listed above are classified as full- or part-time regular students.

Part-time provisional students are individuals who did not meet admission standards but, in the opinion of the Graduate Committee, have the potential for graduate work. Applicants for full- or part-time regular status whose credentials do not warrant acceptance are automatically considered for part-time provisional status.

Upon completion of 12 quarter hours of course work at Northeastern, the provisional student must request a transfer to regular student status in the Graduate Program. To be considered for transfer, six of the 12 credits must be from required courses offered by the Graduate Program in Criminal Justice with a grade of at least B. An overall cumulative grade average of B must be maintained in courses taken outside the College of Criminal Justice.

Special students may take courses on a nondegree basis only by obtaining permission from individual instructors. Should a special student desire admission to the degree program as a regular student, he/she must meet standard admission requirements. Up to 12 credits (no more than two courses per quarter) may be taken as a special student before applying for admission. All courses must result in a grade of B or better; if 12 credits have been completed, six must be from required courses.

Academic Requirements for the Master's Degree

All candidates for the Master's Degree in Criminal Justice are required to complete the following:

1. A total of 42 hours of course credit.
2. Thirty-six of the total 42 hours completed in classroom work, 18 of which are required courses and 18 elective courses.
3. Completion of an acceptable thesis valued at six credits.
4. Satisfactory performance on a comprehensive written examination. Full- and part-time students may apply to take the comprehensive examination when they have completed all course requirements.

Students in the program must earn a grade of B or above in all required and elective courses offered within the Graduate Program in Criminal Justice. An average of B or above is also required in all other elective courses taken within the University. Each student

is expected to maintain an overall average of B or better in all course work to remain in the program.

Within the above limitations, a criminal justice required or elective course for which a grade of F is received must be repeated with a grade of B or better, and may be repeated only once. If a grade of F is received in a university elective course, that course may be repeated once to obtain a grade of C or better, or another elective course may be substituted. If a grade of C is received in a required course, provisions may be made with the professor to correct the deficiency.

Program Selection

Upon acceptance as a degree candidate, the student is assigned a temporary adviser in his/her major area of concentration. In consultation with his/her adviser, the student develops a program of study, including program objectives, anticipated courses, and estimated dates of completion of the various degree requirements. The temporary adviser also helps the student select a thesis committee which assists him/her in all academic matters, as well as in the development and completion of the thesis.

Transfer Credits

Individuals who have been enrolled in other graduate degree programs, who have earned a graduate degree, or who have taken graduate courses on a non-degree basis may be granted credit at the discretion of the Graduate Committee. A maximum of 12 quarter hours of credit from another institution is acceptable providing it meets specified requirements. Courses should be the equivalent of or comparable to courses offered in the Graduate Program in Criminal Justice. If accepted, each course represents three quarter hours of credit. A petition for transfer of credit, obtainable from the College of Criminal Justice, together with official transcripts and course descriptions from the institution(s) attended, must be provided before committee action will be taken.

Comprehensive Examination

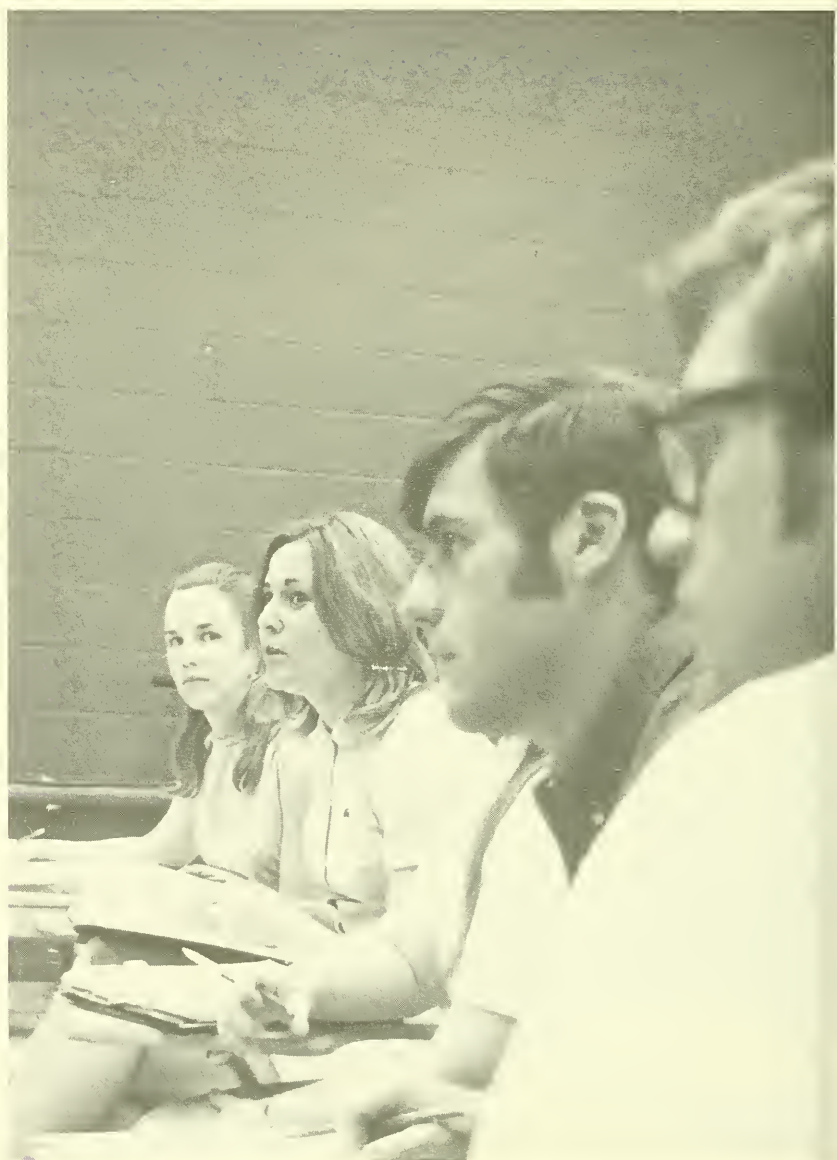
Each candidate takes a comprehensive examination no later than one month prior to the expected date of graduation. This examination may be taken when the candidate has completed all course requirements, as the subjects tested are commensurate with the student's area of concentration.

A grade of B or better must be achieved in the examination. A student who fails may be given a reexamination under conditions determined by the Director of the Graduate Program or his designate.

Thesis

Each candidate must submit a thesis which exhibits his research ability, and increases his scope of individual specialization. The thesis proposal is submitted for approval to the candidate's thesis committee: a chairman and one or two members proposed by the student. Once approved, the thesis committee serves as an advisory board on idea development. The completed thesis must be approved by the thesis committee, graduate committee, and Director of the Graduate Program.





financial information

FINANCIAL OBLIGATIONS

Tuition

Tuition rates and fees are subject to revision by the Board of Trustees at any time. However, any change in tuition and fees will become effective at the beginning of the school year which follows the one in which the change was announced.

Tuition for master's degree candidates and special students is \$57 per quarter hour of credit.

Tuition statements are mailed to students by the Bursar's Office and are payable by check to Northeastern University on or before the date specified.

Fees

All applications must be accompanied by a nonrefundable application fee of \$15. No application will be processed until the fee has been received by the Graduate Program in Criminal Justice. Checks should be made payable to Northeastern University and sent, with the application, to the Graduate Program in Criminal Justice, Northeastern University, 360 Huntington Avenue, Boston, Massachusetts 02115.

Other fees include a charge of \$10 for late payment of tuition and a fee of \$25 for all degree candidates, payable before commencement by the applicable date listed on the academic calendar.

Full-time students are charged \$12.50 per quarter for the services available in the Student Center; part-time students pay \$.75 a quarter.

All financial obligations to the University must be discharged prior to graduation.

Refunds

Tuition refunds are granted only on the basis of the date appearing on the official withdrawal form filed by the student. Nonattendance does not constitute official withdrawal. Questions regarding refunds should be discussed with the Bursar's Office.

Refunds will be granted in accordance with the following schedule:

Official Withdrawal Filed Within	Percentage of Tuition Refunded
First week of quarter	100
Second week	75
Third week	50
Fourth week	25

FINANCIAL AID

There is a limited amount of financial aid for part-time students enrolled in the Graduate Program in Criminal Justice. Graduate assistantships and/or fellowships in the College are not available to part-time students. A limited number of research fellowships may be available to qualified full-time graduate students. Research fellows are selected on the basis of academic background, research potential, and a written research proposal. Assigned duties require 18-20 hours per week for which the student receives a stipend of \$3450 per calendar year and a tuition waiver.

Martin Luther King, Jr., Scholarships

A limited number of full- and part-time Martin Luther King, Jr., Fellowships are available. These scholarships provide for remission of tuition and all fees, and are awarded to qualified black students on the basis of financial need. Additional information and application forms are available from the Office of Financial Aid.

Dormitory Proctorships

A number of proctorships in men's dormitories on or near the Huntington Avenue Campus are available each year. Appointments carry a minimum compensation of room and board. Further information and application forms may be obtained from the Office of University Housing.

National Direct Student Loan

Under provisions of an act of the Federal government, students carrying an academic load of one half or more are entitled to loans up to \$2,500 for one school year and up to a total of \$10,000 for undergraduate and graduate work. The actual amount of any award will be determined on the basis of need and academic promise.

The repayment period begins nine months after the borrower ceases to carry a half-time load and extends 10 years from that point at an annual interest rate of three percent. Up to 100 percent may be cancelled for teachers in special education. Additional

information and application forms are available from the Office of Financial Aid. The application deadline is September 1 for full-time students and one month prior to the start of the quarter for which aid is requested for other students.

Higher Education Loan Plan (Guaranteed Student Loan Plan)

Educational assistance loans may be available from certain banks in the student's home town. These loans, guaranteed by state agencies, carry an interest charge of seven percent, three percent of which is paid by the Federal government. Graduate students may borrow up to \$2,500 for each year of study up to a maximum of \$10,000 for both undergraduate and graduate work. Monthly repayment begins nine to 12 months after completion of study, and extends up to five years for amounts less than \$2,000 or to 10 years for amounts greater than \$2,000. Applicants for this loan are required to complete a need analysis form. Additional information and application forms are available from the Office of Financial Aid.

Law Enforcement Assistance Administration

The Law Enforcement Assistance Administration, U.S. Department of Justice, has set up an Office of Academic Assistance under authority of the Omnibus Crime Control and Safe Streets Act of 1968, Public Law 90-351. Through the University, loans up to \$2,200 per year for tuition and grants up to \$250 per academic quarter for tuition and fees are available to law enforcement personnel in undergraduate or graduate programs leading to degrees or certificates in areas directly related to law enforcement.

The loans, limited to full-time students in or preparing for law enforcement or corrections careers, are cancelled at the rate of 25 percent for each year the recipient subsequently serves in law enforcement at federal, state, or local level.

The grants are available to full-time or part-time students employed in a publicly-funded law enforcement agency, and involve a signed agreement to remain in the service of a law enforcement agency employing such applicant for two years following completion of the course for which aid was given.

Applications for loans or grants should be obtained from the Office of Financial Aid, Room 252 Richards Hall.

Please note: Aid granted from programs sponsored by the federal government is dependent upon the amount of funds allocated to Northeastern. The University does not award financial assistance in any form to non-citizens of the United States.



faculty

GRADUATE TEACHING FACULTY AND STAFF OF THE COLLEGE OF CRIMINAL JUSTICE

Ames, Lois, B.A., M.A., A.C.S.W. certified, *Assistant Professor of Criminal Justice*

Croatti, Robert, B.S., *Assistant to the Dean of Criminal Justice*

Cunliffe, Frederick, B.S., M.S., Ph.D., *Professor of Criminal Justice*

Deming, Romine, B.A., M.S., Ph.D., *Associate Professor of Criminal Justice*

Jimenez, Robert, B.S., M.D., *Lecturer in Criminal Justice*

Kassler, Haskell, B.A., J.D., *Assistant Professor of Criminal Justice*

Natoli, Richard, B.S., M.A., *Assistant Professor of Criminal Justice*

Perry, Reynold, B.S., *Administrative Assistant Graduate Program in Criminal Justice*

Reed, James, B.F.A., M.A., *Assistant Professor of Criminal Justice*

Rosenblatt, Norman, B.A., M.A., Ph.D., *Dean of the College of Criminal Justice, Director of the Graduate Program in Criminal Justice*

Schafer, Stephen, D. Jur., Prof. Agrégé, *Professor of Criminal Justice*

Senna, Joseph, B.A., M.S.W., J.D., *Associate Professor of Criminal Justice*

Sheehan, Robert, B.A., M.A., *Professor of Criminal Justice*

Siegel, Larry, B.A., M.A., *Assistant Professor of Criminal Justice*

Turek, Donna, B.A., M.A., *Assistant Professor of Criminal Justice*

Wintersmith, Robert, B.A., M.S.W., M.A., Ph.D., *Lecturer in Criminal Justice*

fields of study

PROGRAMS IN PROFESSIONAL SPECIALIZATIONS

Master of Science

The master's curriculum is divided into three categories of major concentration: Criminal Justice Administration, Behavioral Science Theory, and Research. Model and specimen programs for each concentration can be found on pages 40-43 in this bulletin.

Students must choose one of the three concentrations and complete one of the programs outlined in the following pages.

Group I Core Curriculum (18 Credits)

This group consists of all required graduate courses offered and taught by the faculty of the College of Criminal Justice. Core courses are taken by all students regardless of major concentration or elective interest. The core curriculum encompasses a broad area of topical information, and comprises a solid foundation for graduate study in criminal justice.

Course

Administration of Criminal Justice	3
Theories in Criminology	3
Legal Issues in Criminal Justice	3
Criminal Justice Planning and Development	3
Statistical Analysis	3
Research Methods in Criminal Justice I	3
	<u>18 credits</u>
THESIS	6
	<u>24 credits</u>
Elective Courses	18
TOTAL PROGRAM	<u>42 credits</u>

Group II

The following list is of elective courses which are offered and taught by the faculty of the Graduate Program in Criminal Justice. These courses involve more specific problems of crime and criminal justice, while the required courses are more general in nature and emphasize the comprehensive systems approach to criminal justice.

Course

Conflict Management in Criminal Justice	3
Deviance, Stigma, and Justice	3
Correctional Services in the Community	3
Penology	3
Juvenile Justice and Delinquency	3
Forensic Science	3
Research Methods II	3
Field Practicum	3

Group III Elective Curriculum

Elective courses offered by and taught in the following graduate programs may be credited toward meeting degree requirements for the Master of Science in Criminal Justice.

Graduate School of Arts and Sciences
 Graduate School of Business Administration
 School of Law
 Graduate School of Professional Accounting
 Graduate School of Engineering
 Graduate School of Education
 Graduate School of Pharmacy and Allied Health Professions
 Graduate School of Boston Bouvé College

MODEL PROGRAM
MASTER'S DEGREE PROGRAM IN CRIMINAL JUSTICE

QUARTER I

Course	Credits
Administration of Criminal Justice	3
Theories in Criminology	3
Statistical Analysis	3
Elective	<u>3</u>
Total	12

QUARTER II

Course	Credits
Research Methods I	3
Legal Issues in Criminal Justice	3
Elective	3
Elective	<u>3</u>
Total	12

QUARTER III

Course	Credits
Criminal Justice Planning and Development	3
Elective	3
Elective	3
Elective	<u>3</u>
Total	12

SUMMARY

	Credits
Thesis	6
Required Courses in Criminal Justice	18
Electives from Criminal Justice and University	<u>18</u>
TOTAL	42

SPECIMEN PROGRAM I

MAJOR CONCENTRATION

Administration, Policy Development, and Planning

QUARTER I

Course	Credits
Administration of Criminal Justice	3
Theories in Criminology	3
Statistical Analysis	3
Criminal Justice Elective	<u>3</u>
Total	12

QUARTER II

Course	Credits
Research Methods I	3
Legal Issues in Criminal Justice	3
Criminal Justice Elective	3
Functions and Techniques of Public Management (22.874)	<u>3</u>
Total	12

QUARTER III

Course	Credits
Criminal Justice Planning and Development	3
Criminal Justice Elective	3
Urban Sociology (21.885)	3
Organization and Administrative Theory (50.953)	<u>3</u>
Total	12

SUMMARY

	Credits
Thesis	6
Required Courses in Criminal Justice	18
Elective Courses in Criminal Justice	9
Elective Courses from University	<u>9</u>
TOTAL	42

SPECIMEN PROGRAM II**MAJOR CONCENTRATION****Behavioral Science Theory****QUARTER I**

Course	Credits
Administration of Criminal Justice	3
Theories in Criminology	3
Statistical Analysis	3
Criminal Justice Elective	3
Total	12

QUARTER II

Course	Credits
Research Methods I	3
Legal Issues in Criminal Justice	3
Criminal Justice Elective	3
Personality and Social Structure (50.805)	3
Total	12

QUARTER III

Course	Credits
Criminal Justice Planning and Development	3
Criminal Justice Elective	3
Foundations of Social Theory (21.805)	3
Social Psychology I (19.920)	3
Total	12

SUMMARY

	Credits
Thesis	6
Required Courses in Criminal Justice	18
Elective Courses in Criminal Justice	9
Elective Courses from University	9
TOTAL	42

SPECIMEN PROGRAM III

MAJOR CONCENTRATION

Research

QUARTER I

Course	Credits
Administration of Criminal Justice	3
Theories in Criminology	3
Statistical Analysis	3
Criminal Justice Elective	<u>3</u>
Total	12

QUARTER II

Course	Credits
Research Methods I	3
Legal Issues in Criminal Justice	3
Criminal Justice Elective	3
Operations Research for Criminal Justice	<u>3</u>
Total	12

QUARTER III

Course	Credits
Criminal Justice Planning and Development	3
Criminal Justice Elective	3
Research Methods II	3
Introduction to Data Processing	<u>3</u>
Total	12

SUMMARY

	Credits
Thesis	6
Required Courses in Criminal Justice	18
Elective Courses in Criminal Justice	12
Elective Courses from University	<u>6</u>
TOTAL	42

courses

DESCRIPTION OF COURSES

All courses carry three quarter hours of credit unless otherwise specified.

92.904 Administration of Criminal Justice

A description and analysis of the criminal justice process from prevention and arrest to release after incarceration. Concentration is on a systems approach to understanding criminal behavior. The philosophies, practices, and procedures of agencies responsible for the administration of justice are viewed and critical efforts made to deal with the effectiveness of different approaches to crime control.

92.907 Theories in Criminology

The history and development of criminological theories from ancient to contemporary times. It examines the assumptions of theoretical models and relates them to the development of criminal policies. Psychological, sociological, and cultural theories underlying deviant criminal behavior are reviewed.

92.910 Nature and Extent of Crime

An extensive examination into the nature and volume of crime in the U.S. and foreign countries. Course content includes types of crimes and offenders, geographic distribution of crime patterns, cost of crime, and a critical review of techniques used to measure crime.

92.913 Criminal Justice Planning and Development

Introduction to planning techniques and their impact on criminal justice program development, now and in the future. Policy and decision making procedures pertaining to affiliated agencies and organizations are analyzed. The extent of planning for crime control on local, state, regional, and national level is studied. The peculiar nature of urban crime problems in relation to planning is also reviewed. Planning involves identification of problem areas, diagnosing causation, formulating solutions, alternative strategies, and mobilizing resources necessary to effect change in the system.

92.916 Statistical Analysis

An analysis of the application of statistics in research, and the basic assumptions underlying statistical procedures. The course covers descriptive and inferential statistical procedures such as sampling, laws of probability theory, hypothesis testing, analysis of variance, and multiple regression.

(Students with a background in statistics may make a special request to replace this course with an elective.)

92.957 Research Methods in Criminal Justice I

Survey of methods and approaches utilized for independent research, as well as the evaluation of existing criminal justice programs. It considers research methods and empirical findings through assigned research techniques including design, instrument construction, data processing, and analysis interpretation.

92.958 Research Methods in Criminal Justice II

Advanced research design problems are examined. Criminal justice programs are evaluated quantitatively, with concentration placed on coding, schedule construction, sampling theory, and statistical models measuring causation.

92.841 Criminal Law

General principles of the criminal law, including the concept of responsibility for crimes, limitations on capacity and basic elements of crimes. The sources and purposes of criminal law are analyzed, and different conceptions of crime and current law reform are discussed.

92.800 Law Enforcement Practices

This course involves a study of the current theory and practices in the field of law enforcement. Major problems which confront the law enforcement process are considered, as well as the methods now used by law enforcement agencies.

92.804 Correctional Services in the Community

An analysis of treatment and supervisory activities, including probation and parole for offender groups while in the community. There is a thorough exploration of community resources and services such as vocational rehabilitation, welfare services, mental health clinics, employment services, and legal aid. Effectiveness of community treatment is examined through case studies.

92.810 Penology and Corrections

This course deals essentially with the process of incarceration and the social structure of the prison community. Consideration is given to management, operation effects, and the effectiveness of different

institutions. Modern correctional approaches and current rehabilitation practices are also discussed.

92.816 Social Deviance

Crime as a form of social deviance is studied through intensive reading of a wide range of sociological literature on deviant behavior and its relationship to crime. Included are relevant selections from Durkheim, Merton, Cohen, Goffman, Becker, Matza, Ohlin and Schur.

92.851 Juvenile Justice and Delinquency

A study of the juvenile justice system beginning with community concern to the subsequent disposition. The class analyzes juvenile and family court procedures, as well as questions of jurisdiction. Various theories of delinquency developed from law, sociology, psychology, and related disciplines are also covered.

92.822 Forensic Science

The development of forensic science is summarized according to its effects on the criminal justice system. Lecture and laboratory work examine various ways the physical sciences contribute to the establishment of scientific criminal evidence. Designed primarily for students who plan to enter a profession requiring an understanding of criminalistics.

92.828 Field Practicum

Field instruction in a criminal justice agency where the instruction may be given in administration, research, teaching and/or related activities. Students have the opportunity to apply theoretical concepts in a practical, applied fashion by observing and contributing to the daily activities of operating agencies and organizations.

92.860 Conflict Management in Criminal Justice

An examination of problems in conflict management. Concepts and definitions of social conflict are explored, as well as comparisons between functional and dysfunctional conflict. Inquiries into representative conflict management strategies and techniques are made which afford the opportunity to relate general theory and research results to practical situations of criminal justice conflict management. A variety of heuristic techniques are anticipated, such as: scenarios, roleplaying, and use of audio-visual media.

92.809 Deviance, Stigma and Justice

Stigmatization is accurately defined as it is found to exist in different segments of our society. Its history in the United States is traced through examples of specific topics, such as: employment of ex-offenders, social acceptance of mental patients, ethnic discrimination, and homosexuality.

92.806 Conflicting Values and the Criminal Justice System

An investigation of ideologies, institutions, and ethnic mores as they affect black values and reactions to the criminal justice system. Integration, rebellion, and institutionalization are subjects of discussion.

92.830 History of Police in the United States

A review of the history of police activities in the United States emphasizing black community relations. The study of previous policy provides a broad, revealing perspective from which to view contemporary departments. From this framework, the class analyzes societal expectations of the police.

92.808 Criminal Behavior, Psychiatry, and the Public

An introduction to the field of psychiatric criminology which examines the known psychological sources of criminal behavior. Psychiatric concepts are applied to crime prevention, the examination and rehabilitation of the offender, and the legislative process.

92.862 Drug Abuse, Mental Health and the Public

An introductory course concerning drug abuse. The mental health and medico-legal aspects of the problem are emphasized by concentrating on the areas of prevention and rehabilitation, public attitudes on drug abuse, and drug abuse education.

92.905 Legal Issues in Criminal Justice

An in-depth study of contemporary legal questions faced by criminal justice professionals. Emphasis is placed on constitutional problems, as well as the judicial review of administrative decisions made by criminal justice organizations. Topics to be considered are: selected provisions of the United States Constitution with particular emphasis on amendments 4, 5, 6, and 14; questions of electronic surveillance; right to counsel; line-up, bail and right to speedy trial; sentencing; legal aspects of probation and parole; and prisoners' rights.

index

A

Academic Council, 13
Academic Requirements, 28
Address of University, 1
Administration
 University, 11
 Graduate Division, 14
Application Procedure and
 Admission Requirements, 28

B

Board of Trustees, 9
Buildings and Facilities, 22

C

Calendar, 5
Campus Description and Location, 22
 Map, 4
Changes in Requirements, 28
Class Hours, 27
Classifications, Academic, 29
Colleges, Undergraduate, 19
Committee on Graduate Study in
 Criminal Justice, 18
Committees, General University, 13
Comprehensive Examination, 30
Contents, 3
Continuing Education, Center for, 20
Continuity of Program, 27
Cooperative Plan of Education, 19
Corporation, 7
Courses, Description of, 44
Credits, 29
 Transfer, 30
Curriculum, 38.

D

Degree Requirements, 29
Dormitory Proctorships, 34

E

Elective Courses, 39
Executive Council, 13

F

Faculty, 37
Faculty Senate, 14
Fees, 33
Fields of Study, 38
 Criminal Justice Administration, 41
 Behavioral Science Theory, 42
 Research, 43
Financial Information, 34
Full-Time Program, 26

G

Grading System, 27
Graduate and Professional Schools, 19

H

Henderson House, 24
Higher Education Loan Plan, 35
Holidays, 6

L

Libraries, 22
Living Accommodations, 23
Loans, 34, 35

M

Map of Campus, 4
Marine Science Institute, 24

N

National Direct Student Loans, 34

P

Part-Time Program, 26
Programs, types of, 26

R

Refunds, 34
Registration, 26
Regulations, 26
Research Activities, 20
Residence, Academic, 26
 Facilities, 22
Required Courses, 38

S

Schools, Graduate and Professional, 19
Student Center, 22
Suburban Facilities, 23

T

Thesis, 31
Transfer Credit, 30
Trustees, 9
Tuition, 33

U

University Council, 13
University, Description of, 19
University Graduate Council, 15

W

Warren Center, 24
Withdrawals, 27

northeastern university bulletin



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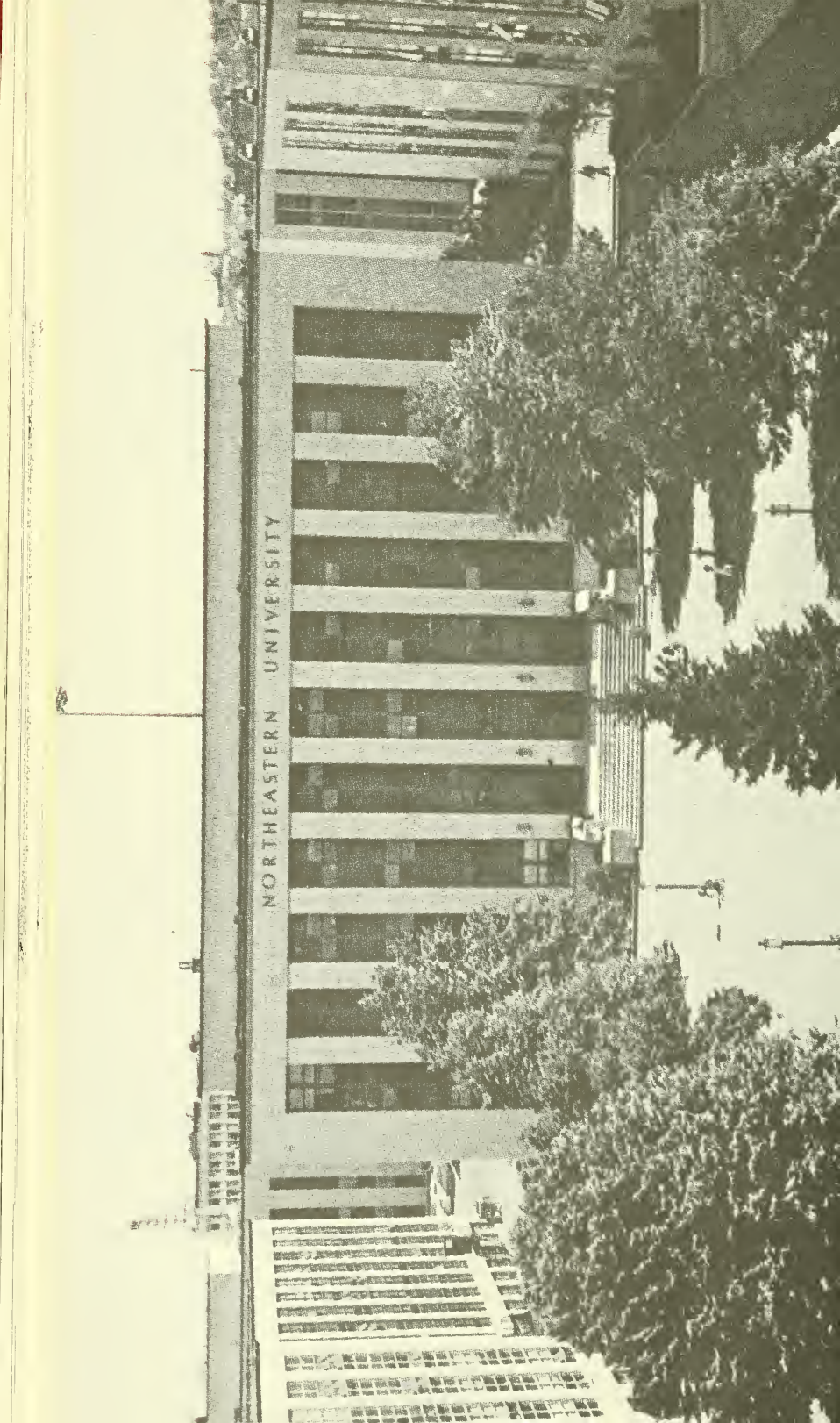


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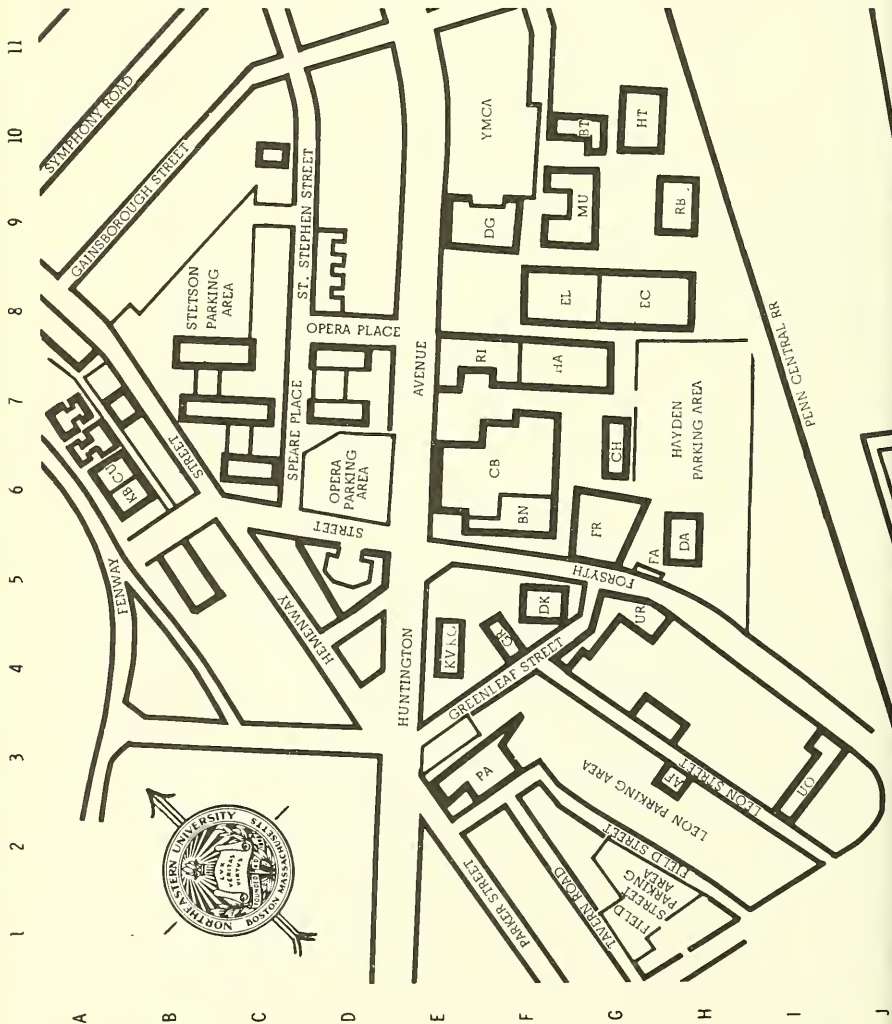
Boston-Bouvé College Graduate School 1974-75

NORTHEASTERN UNIVERSITY



contents

4	Campus Map
5	Academic Calendar
6	University Holidays
7	The Governing Boards and Officers of the University
7	Corporation
9	Board of Trustees
11	Administrative Organization
13	General University Committees
14	Organization of the Graduate Schools
19	The University
21	Buildings and Facilities
24	Boston-Bouvé College Graduate School
25	Part-Time Study
25	General Regulations
27	The Master of Science Degree
31	Financial Information
31	Financial Obligations
32	Financial Aid
35	Faculty
36	Fields of Study
36	Programs in Professional Specializations
39	Courses
39	Physical Education
42	Recreation Education
44	Interdepartmental Courses
47	Index



**MAP
REFERENCE**

- F6
F10
E6
G7
A6
H6
F5
E9
G8
F8
G6
G5
F4
F7
G10
B6
E4
E4
J3
H3
F9
F3
E7
H9
G5

Building

- Barletta Natatorium
Botolph Building
Cabot Physical Education Ctr.
Churchill Hall
Cushing Hall
Dana Research Center
Dockser Hall
Dodge Library
Eli Student Center and Alumni Auditorium
Forsyth Building
Forsyth Building Annex
Greenleaf Building
Hayden Hall
Hurting Hall
Kennedy Building
Knowles Center (Volpe)
Knowles Center (Gryzmish)
11 Leon Street
Afro-American Institute
Mugar Life Sciences Building
Parker Building
Richards Hall
Robinson Hall
United Realty Building

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Designation**

- BN
BT
CB
CH
CU
DA
DK
DG
EL
FR
FA
GR
HA
HT
KB
KV
KG
MU
PA
RI
RB
UR

ACADEMIC CALENDAR 1974-75

Fall Quarter 1974

Registration period		
Burlington	Wednesday-Thursday	Sept. 18-19
Boston	Monday-Thursday	Sept. 23-26
Interview period for new students by appointment*	Wednesday-Thursday	Sept. 23-26
Classes begin	Monday	September 30

Winter Quarter 1974-75

Registration period		
Burlington	Tuesday	December 3
Boston	Monday-Thursday	Dec. 9-12
Interview period for new students by appointment*	Monday-Thursday	Dec. 9-12
Classes begin	Monday	January 6

Spring Quarter 1975

Registration period		
Burlington	Tuesday	March 11
Boston	Monday-Thursday	Mar. 17-20
Classes begin	Monday	April 7
Last day to file commencement card for spring commencement	Tuesday	April 1
Last day to pay fee for spring commencement	Wednesday	April 30
Final grades due in Registrar's Office for June graduates taking third quarter course	Friday	June 6
Spring commencement	Sunday	June 22

Summer Quarter 1975

Registration period		
Burlington	Monday-Tuesday	June 16-17
Boston	Wednesday-Thursday	June 18-19
Classes begin	Monday	June 30
Duration of summer quarter	Monday-Friday	June 30-Aug. 8
Last day to file commencement card for fall commencement	Tuesday	July 1
Last day to pay fee for fall commencement	Friday	August 1
Fall commencement	Thursday	September 11

*Appointments for interviews with new students must be made at least four days before the date of the interview.

UNIVERSITY HOLIDAYS 1974-75

Columbus Day	Monday	October 14
Veterans' Day	Monday	October 28
Thanksgiving Recess	Thursday-Saturday	Nov. 28-30
Christmas Vacation	Monday-Tuesday	Dec. 23-Jan. 4
Washington's Birthday	Monday	February 17
Patriots' Day	Monday	April 21
Memorial Day	Monday	May 26
Independence Day	Friday	July 4
Labor Day	Monday	September 1

Equal Opportunity Policy

Northeastern University is committed to a policy of providing equal opportunity for all. In all matters involving admission, registration, and all official relationships with students, including evaluation of academic performance, the University insists on a policy of nondiscrimination. Northeastern University is also an equal opportunity employer; it is institutional policy that there shall not be any discrimination against any employee or applicant for employment because of race, color, religion, sex, age or national origin. In addition, Northeastern takes affirmative action in the recruitment of students and employees.

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John D. Post, *Assistant Professor of History*

Robert Raffauf, *Professor of Pharmacognosy and Medicinal Chemistry*

John F. Reinhard, *Professor of Pharmacology*

Richard J. Scranton, *Assistant Professor of Civil Engineering*

Joseph Senna, *Associate Professor of Criminal Justice*
 Albert Soloway, *Chairman of the Department of Medicinal Chemistry
 and Pharmacology and Director of the
 Graduate School of Pharmacy
 and Allied Health Professions*
 Yogendra N. Srivastava, *Associate Professor of Physics*
 Michael Terman, *Associate Professor of Psychology*
 Dharmendra Verma, *Associate Professor of Marketing*
 Elizabeth Van Slyck, *Professor of Physical Therapy*
 Arthur Weitzman, *Professor of English*
 Robert N. Wiener, *Associate Professor of Chemistry*
 Richard Zobel, *Professor of Physical Education*

Administrative Committee of the Graduate Schools

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 Francis W. Casey, *Secretary, Registrar of the Graduate Schools*
 Catherine L. Allen, *Director of Boston-Bouv  College Graduate School*
 Alvah K. Borman, *Dean of Graduate Placement Services*
 Barbara Burke, *Executive Assistant to the Dean of the School of Law
 and Director of Placement for the School of Law*
 Geoffrey Crofts, *Director of the Graduate School of Actuarial Science*
 Philip T. Crotty, Jr., *Associate Dean of Business Administration*
 Joseph M. Golemme, *Director of the Graduate School of
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 George W. Hankinson, *Director of the Graduate School of Engineering*
 James S. Hekimian, *Dean of Business Administration*
 John W. Jordan, *Associate Dean of Business Administration and Director
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 and Allied Health Professions*
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 Alan A. Mackey, *Associate Dean of University Administration and
 University Registrar*
 Melvin Mark, *Dean of Engineering*
 Frank E. Marsh, Jr., *Dean of Education*
 Edmund J. Mullen, *Assistant Dean of University Administration and
 Associate University Registrar*
 John C. O'Byrne, *Dean of the School of Law*
 Barbara Philbrick, *Associate Professor of Physical Education and
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 Graduate School*
 Marianne Radziewicz, *Registrar of the School of Law*

Norman Rosenblatt, *Dean of Criminal Justice and Director
of the Graduate Program in Criminal Justice*

Philip J. Rusche, *Director of the Graduate School of Education*

Robert A. Shepard, *Dean of Liberal Arts*

Albert Soloway, *Director of the Graduate School of Pharmacy and Allied
Health Professions*

Ex Officio

Arthur E. Fitzgerald, *Dean of Faculty*

Rudolph M. Morris, *Dean of University Administration*

Loring M. Thompson, *Dean of Planning*

Committee of Boston-Bouvé College Graduate School 1974-75

Catherine L. Allen, *Director, Dean of Boston-Bouvé College*

Carl S. Christensen, *Representative for Physical Education, Chairman of
Physical Education*

H. Marie Garrity, *Representative for Health Education, Executive Officer
and Associate Professor of Health Education*

Albert H. McCay, *Representative for Recreation Education, Chairman of
Recreation Education*

Barbara Philbrick, *Representative for Physical Education and
Coordinator of Graduate Programs*

Alae-Eldin Sayed, *Representative for Recreation Education, Assistant
Professor of Recreation Education*

Elizabeth W. Van Slyck, *Representative for Physical Therapy,
Professor of Physical Therapy*

Richard C. Zobel, *Chairman, Professor of Physical Education*

the university

Founded in 1898, Northeastern University is incorporated as a privately endowed nonsectarian institution of higher learning under the General Laws of Massachusetts. The State Legislature by special enactment has given the University general degree-granting powers. The University is governed by a Board of Trustees elected by and from the Northeastern University Corporation, which is composed of nearly 180 distinguished business and professional men and women.

From its beginning, Northeastern University has had as its dominant purpose the discovery of community educational needs and the meeting of these in distinctive and serviceable ways. The University has not duplicated the programs of other institutions, but has sought to pioneer new areas of educational service.

A distinctive feature of Northeastern University is its Cooperative Plan, initiated by the College of Engineering in 1909 and subsequently adopted by the Colleges of Business Administration (1922), Liberal Arts (1935), Education (1953), Pharmacy (1962), Nursing (1964); Boston-Bouvé College (1964); the College of Criminal Justice (1967); and by Lincoln College's daytime Bachelor of Engineering Technology program (1971). This educational method enables students to gain valuable practical experience as an integral part of their college program and also provides the means by which they may contribute substantially to the financing of their education. The Plan has been extended to the graduate level in engineering, actuarial science, rehabilitation administration, professional accounting, business administration, and law.

In the field of adult education, programs of study have been developed to meet a variety of needs. University College offers evening courses — offered by the University since 1906 — and adult-day courses leading to the bachelor's degree. In addition to offering day undergraduate programs in Electrical Engineering Technology and Mechanical Engineering Technology, Lincoln College offers evening/part-time certificate, associate, and bachelor degree programs in technological areas. All formal courses of study leading to degrees through part-time programs are approved by the Basic College faculties concerned.

GRADUATE AND PROFESSIONAL SCHOOLS

The 10 graduate and professional schools of the University offer day and evening programs leading to the degrees listed.

The Graduate School of Actuarial Science offers the degree of Master of Science in Actuarial Science.

The Graduate School of Arts and Sciences offers the degrees of Master of Arts, Master of Science, Master of Science in Health Science, Master of Public Administration, and Doctor of Philosophy.

The Graduate School of Boston-Bouvé College offers the degree of Master of Science, with specialization in Physical Education and Recreation Education.

The Graduate School of Business Administration offers the degree of Master of Business Administration.

The Graduate Program in Criminal Justice offers the degree of Master of Science.

The Graduate School of Education offers the degree of Master of Education and the Certificate of Advanced Graduate Study.

The Graduate School of Engineering offers the degrees of Master of Science, Engineer degree, Doctor of Engineering, and Doctor of Philosophy.

The School of Law offers the degree of Juris Doctor.

The Graduate School of Pharmacy and Allied Health Professions offers the degrees of Master of Science and Doctor of Philosophy.

The Graduate School of Professional Accounting offers the degree of Master of Science in Accounting.

CENTER FOR CONTINUING EDUCATION

The Center for Continuing Education was established in 1960 to relate the University to the needs of its community in a period of accelerated change. Adult education programs offered by the Center and University College have since been consolidated. Its programs are composed of seminars, conferences, institutes, forums, and a wide variety of special courses designed to serve specific needs. The Division of Special Programs, working cooperatively with trade associations and professional societies, offers a wide variety of programs dealing with current needs and problems. Through its Division of Community Services, working with governmental agencies and community organizations, the Center is becoming increasingly involved in social problems on both the local and national level.

Many of these programs are conducted at Henderson House, Northeastern University's conference center in Weston, Massachusetts.

RESEARCH ACTIVITIES

The facilities of the University are engaged in a wide variety of basic research projects in business, science, social science, pharmacy, and engineering. These are coordinated by the Dean of Research, whose services are University-wide and available to the faculties of all the Colleges.

Although Northeastern is primarily concerned with undergraduate and graduate instruction, the University believes that the most effective teaching and learning take place in an environment characterized by research activities directed toward extending the frontiers of knowledge.

buildings and facilities

MAIN CAMPUS

The main campus of Northeastern University is located at 360 Huntington Avenue in the Back Bay section of Boston. Many of the city's famous cultural, educational, and philanthropic institutions are situated in the Back Bay, including the Museum of Fine Arts, Symphony Hall, Horticultural Hall, the Isabella Stewart Gardner Museum, the Harvard teaching hospitals, the Boston Public Library, and many schools and colleges. Most are within walking distance of Northeastern University.

Major transportation facilities serving the Boston area are Logan International Airport, two rail terminals, bus terminals serving inter- and intrastate lines, and MBTA subway-bus service within the metropolitan-suburban area. There is a subway stop in front of the campus. For motorists, the best routes to the campus are the Massachusetts Turnpike (Exit 22) and Route 9, of which Huntington Avenue is the intown section.

The campus of 48 acres is divided by Huntington Avenue, with the main educational buildings on one side and dormitories on the other. The principal buildings, all of which have been constructed since 1938, are of glazed brick in contemporary classic style. Most are interconnected by underground passageways.

Ell Student Center

The Carl S. Ell Student Center provides facilities for student recreation and for extracurricular activities. The Alumni Auditorium, with a seating capacity of 1,300, is part of the Center. Also included are special drama facilities, a ballroom, main lounge, fine arts exhibition area, student offices, conference rooms, and a dining area seating more than 1,000.

Libraries

The University library system consists of the Dodge Library, which is the main library; the Suburban Campus Library at Burlington; the School of Law Library; and divisional libraries for Physics and Electrical Engineering, Chemistry and Biology, Mathematics and Psychology, and Health, Physical and Recreation Education, and Physical Therapy. There are additional subject collections for the Center for Management Development at Andover, Massachusetts, and the Marine Science Institute in Nahant.

The library collections number 360,000 volumes supplemented by some 267,000 titles in microprint, microfilm, and microfiche forms. The collection includes, in addition, some 3,500 periodical titles, 90,000 documents, and 4,600 sound recordings.

Cabot Physical Education Center

The Godfrey Lowell Cabot Physical Education Center is one of the best equipped in New England. The large gymnasium contains four basketball courts. In addition, the Center consists of an athletic cage, a small gymnasium, and a rifle range, as well as administrative offices for the Department of Athletics and for the Physical Education Department of Boston-Bouvé College.

A recent addition to the center, the Barletta Natatorium, houses a 105-foot swimming pool, a practice tank for the crew, handball courts, and shower and dressing facilities.

Dockser Hall

Charles and Estelle Dockser Hall, completed in 1968, houses a large gymnasium, dance studio, motor performance laboratory, college library, community recreation laboratory, folk arts center, dark and music rooms, recreation resources area, locker rooms, offices, classrooms, conference room and lounge, storage facilities, and a research laboratory.

Apartments for Graduate Students

The University maintains a 100-apartment housing unit which accommodates 279 people. Two-, three-, and four-party apartments are available which vary in size from two to four rooms plus bath. Apartments are furnished with beds, chairs, desks, stove, refrigerator, and kitchen table. The cost includes all utilities.

A \$50 deposit is required when making application for the apartments. Applications are available in the Office of University Housing. Students are expected to make such arrangements on a term-to-term basis but may live in the apartments both while on cooperative work assignments and in school if they wish. All reservations are made on a first come first served basis.

SUBURBAN FACILITIES

Suburban Campus

The Suburban Campus, located near the junction of Routes 128 and 3 in Burlington, Massachusetts, was established to meet the needs of individuals and of industry in the area.

In addition to graduate courses in engineering, physics, mathematics, business administration, science, education, and the arts, portions of undergraduate programs leading to the associate and bachelor's degrees, special programs for adults, and noncredit state-of-the-art programs are offered.

Warren Center

The Warren Center is a practical laboratory for Boston-Bouvé College in outdoor education and conservation, in group practicum, and in camping administration, programming, and counseling. At this Center in Ashland, completed in 1967, there are tennis courts, field hockey and lacrosse fields, waterfront for swimming and boating, overnight camp sites, fields and forests, heated cottages, the Hayden Lodge with a recreation hall, library, crafts shop, dining facilities, and conference accommodations.

Henderson House

The University's conference center, Henderson House, is located in Weston, Massachusetts. The Center for Continuing Education conducts short-term courses, seminars, and special institutes for business, professional, and research groups. Henderson House is 12 miles from the main campus.

Marine Science Institute

The Marine Science Institute at Nahant, Massachusetts, is a research and instructional facility primarily engaged in studies of marine biology and oceanography. The Institute is operated all year, and is about 20 miles northeast of Boston. Many of the courses at this institute are applicable toward an advanced degree in biology or health science.

Government Center Campus

With the cooperation of the Federal Executive Board, the Graduate School of Liberal Arts' Department of Political Science offers an entire Master of Public Administration program at the John F. Kennedy Building in downtown Boston. This program is primarily for individuals employed in Federal, state, or local civil services.

Brockton, Nashua, and Framingham Campuses

For students residing in southeastern Massachusetts and northeastern Rhode Island, the Graduate School of Business Administration offers a significant portion of its M.B.A. Program at facilities in Brockton, Massachusetts. These facilities, made available by the Knapp Corporation, are located on West Chestnut Street in Brockton.

Students residing in the southern New Hampshire area may take a significant portion of the M.B.A. Program at facilities in Nashua, New Hampshire. These facilities are furnished by Sanders Associates, Inc. and are located in their headquarters on Route 3, just over the Massachusetts line.

For students in the Framingham-Worcester area, a significant portion of the M.B.A. Program may be taken at classroom facilities located in Framingham, Massachusetts.

boston-bouvé college

graduate school

The purposes of advanced study in Boston-Bouvé College are consistent with the philosophy of Northeastern University, and with the goals of advanced study in the professions. The programs are designed to fulfill the needs and interests of personnel in physical and recreation education in an era of social and educational change and redirection.

Graduate study is founded in the fields of knowledge and specialization which are extensively explored in upper-division or upper-class years of undergraduate preparation. The nature of advanced study leading to the master's degree demands of students and faculty attitudes of intensive critical analysis; cognitive development of idea and thought reliably tested in scholarly search and discussion, with application involving educational resources and practice; specialized research and creative experimentation in emerging theories, with application in the primary specialized field and its ancillary contexts; exploration and development of new trends in curriculum theory, process, and evaluation; critiques of professional reading and related literature; conversance with diverse methods and interpretation of scientific, philosophic, historical, and descriptive research; and a depth study using the appropriate research method in an approved investigation or thesis under faculty advisement.

The goals of graduate education in Boston-Bouvé College are:

1. To provide advanced preparation for administrators, supervisors, teachers, recreation specialists, coaches, and researchers through specific professional study and interdisciplinary experience.
2. To develop appreciation for the orderly approach to discovery through research, philosophical thought, and discussion.
3. To provide a sound basis for research and to facilitate student research experiences and applications.
4. To contribute to the development and refinement of dance, games, sports, recreation, and outdoor education within their cultural settings, and through comparative study.
5. To develop leaders and teachers capable of designing current and innovative approaches to learning and curriculum development.

6. To encourage intensive study in a specialized area of concern, with awareness of problems in education and society.
7. To provide a foundation for advanced study at the doctoral level.

PART-TIME STUDY

Graduate programs in Boston-Bouvé College are structured to provide an opportunity for the master's degree candidate to attend classes in the late afternoon or evening while continuing his/her full-time employment. By judicious use of electives and independent study, an unemployed student may carry the equivalent of a full-time course load.

Students normally take one or two courses per quarter and can complete the degree program in two to three years, depending upon whether or not course work is taken during the summer quarter.

Students maintaining a satisfactory academic standing may petition the Director of the Graduate School for permission to take more than two courses per quarter.

GENERAL REGULATIONS

The general regulations and minimum requirements for all graduate programs are established by the Northeastern University Graduate Council. In some matters the committee of each graduate school is allowed discretion to establish regulations within limits defined by the Council. The regulations and academic requirements which follow have been formulated in accordance with this general policy.

Application

All applicants should address inquiries to Boston-Bouvé College Graduate School. Application forms and information will be mailed promptly.

Registration

Students must register within the period listed on the school calendar. Registration will not be permitted after this period.

Residence

All work for advanced degrees must be completed in residence at the University, unless approval has been obtained from the Director of the Boston-Bouvé College Graduate School for work taken elsewhere. Students who are in residence and using the facilities of the University must register for such work.

Grading System

The performance of students in graduate courses is recorded by the instructor, using the following grades:

- A Excellent
For performance of high graduate caliber
- B Satisfactory
For performance at a satisfactory level
- C Fair
For performance not at the level expected in graduate work
- F Failure
For unsatisfactory performance

In addition, the following letter designations are used:

- I Incomplete
For failure to complete course work
- S Satisfactory without quality designation
For satisfactory completion of course work
- U Unsatisfactory without quality designation

The grades S and U are used for the first quarter of a two-quarter sequence in which the second-quarter grade applies to both the first and second quarters of the sequence: e.g., Thesis I and II.

The designation I is to be changed to a grade upon removal of the deficiencies which caused the I to be reported. Deficiencies must be removed within the quarter following that for which the I is received, unless an extension of time is granted by the instructor. However, such extension of time may not exceed two additional consecutive calendar quarters. Grades of Incomplete received in Thesis I and II may be continued beyond the two-quarter limit, but must be removed prior to graduation and within the six-year time limitation.

Any student who wishes to take a make-up examination must obtain permission from the Director of Boston-Bouvé College Graduate School by the second week of the quarter succeeding that in which the examination is missed. The make-up examination must be taken in that succeeding quarter unless circumstances warrant permission from the Director to defer it to the second succeeding quarter.

Class Hours and Credits

All credits at Northeastern University are entered as quarter-hour credits, with a quarter hour of credit being equivalent to three-fourths of a semester hour, i.e., 12 semester hours are equal to 16 quarter hours.

All classes in the Boston-Bouvé College Graduate School meet on a quarter basis, with an academic quarter defined as a term of approximately 12 weeks' duration. In the summer quarter, classes meet in a quarter of six weeks' duration. The academic calendar in the front of this

bulletin should be consulted to determine the opening dates of each quarter.

Continuity of Program

Students are expected to maintain continuous progress toward a degree. Any student who does not attend Northeastern for a period of one year must apply for readmission.

Withdrawals

In order to withdraw from a course, a student must fill out an official withdrawal form obtained at the Registrar's Office or at the Burlington Campus. Withdrawals may be made through the ninth class meeting of the quarter. Students will be withdrawn as of the date on which they complete the form. Ceasing to attend a class or notifying the instructor does not constitute an official withdrawal. Petitions for withdrawal from a course after the ninth class meeting of the quarter must be submitted to the Director of the Graduate School, and may be approved to avert unusual hardships on the student.

Students who do not attend the first two sessions will be dropped from the class unless they notify the Registrar of their intention not to withdraw.

Changes in Requirements

The continuing development of the Graduate School forces frequent revision of curricula. In every new bulletin, some improvements are indicated. When changes impose no hardship on the student and school facilities permit, the student is expected to meet the requirements of the latest bulletin. If the student finds it impossible to meet these requirements, the bulletin for the year in which he entered becomes the binding one.

Application for the Diploma

If a commencement card is not filed with the Registrar's Office on or before the applicable date listed on the calendar, there is no assurance that the degree will be granted in that particular year, even though all other requirements have been fulfilled.

THE MASTER OF SCIENCE DEGREE

Admission to Degree Candidacy

For admission to the Boston-Bouvé College Graduate School, a degree candidate must have presented the following to the Director of the Graduate School:

1. A completed application and \$15 application fee.
2. Official transcript(s) from accredited institution(s) as evidence of successful completion of the baccalaureate degree. The transcript(s) should show a cumulative average of 2.5 or better and a minimum of 18 semester hours or 24 quarter hours of work in the student's proposed major or related field.
3. Record of an interview with the Director of the Boston-Bouvé Graduate School or her designate. This requirement may be waived for out-of-state applicants.
4. Three references from persons familiar with the applicant's professional, academic, and character background.
5. An official record of the Miller Analogies Test score.

It is recommended that all materials be on file in the office of Boston-Bouvé College Graduate School at the time of the initial interview. In no case will a conference and course registration be permitted without a minimum of a completed application and a copy of the undergraduate transcript. The additional materials—the Miller Analogies Test score and references—must be received not later than the end of the sixth week of the first quarter.

Academic Classifications

Students whose materials meet the criteria listed above are classified as regular students.

Students whose materials do not qualify them for enrollment as regular students may be accepted as provisional students. Provisional students must obtain a B average in the first 12 quarter hours of credit at Northeastern University in order to continue the graduate program.

The Director of Boston-Bouvé College Graduate School may admit any person as a special student who presents evidence of a bachelor's degree and who appears otherwise prepared to undertake study in the Graduate School. Admission is on the provision that the applicant: a) files an application and b) acknowledges that should he subsequently wish to be reclassified as a degree candidate, only 12 quarter hours of academic credit earned as a special student may be applied toward a degree.

Academic Requirements

A candidate for the master's degree must complete an approved program conforming to requirements of the department in which he is registered. At the discretion of the Graduate Committee, any student whose record is not satisfactory may be dropped from the program. A minimum of 48 quarter hours of correlated, graduate-caliber work, along with other study required by the department, must be completed.

An average grade of at least B must be obtained in the quarter hours of credit required for the degree, excluding any transfer credits. Not more than eight quarter hours of extra or repeated courses are allowed to satisfy grade requirements for the degree.

Within the above limitations, a required course for which a grade of F is received must be repeated with a grade of C or better, and may be repeated only once. If a grade of F is received in an elective course, that course may be repeated once to obtain a grade of C or better, or another elective course may be substituted. If a grade of C is received in a required course, that course may be repeated once to obtain a grade of B or better.

A degree candidate's record is subject to review by the Boston-Bouvé College Graduate Committee upon completion of his sixth course at Northeastern University. At this time, he must have made reasonable progress in achieving his program objectives, and have obtained at least a B average. If the requirements are met, he is encouraged to continue the program. In the event his record is unsatisfactory, he may be dropped as a degree candidate from the Boston-Bouvé College Graduate School.

Program Selection

Upon acceptance as a degree candidate, the student is assigned to a program adviser in his major area of concentration. In consultation with his adviser, the student develops a program of study, including program objectives, anticipated courses, and estimated dates for completion of the various degree requirements. Prior to completion of the first 12 quarter hours of credit, the program requires approval by the Boston-Bouvé College Graduate Committee. Any subsequent changes in program require further Committee approval.

Transfer Credits

A maximum of 12 quarter hours of credit obtained at another institution is accepted toward the master's degree, provided that the credits are recommended for transfer by the student's program adviser; consist of work taken at the graduate level for graduate credit; carry grades of A or B; have been earned at a recognized institution; and have not been used toward any other degree. Students should petition the Director of the Graduate School in writing for all transfer credit, completing the necessary form obtainable from either the office of Boston-Bouvé College or the faculty program adviser. This form should be submitted to the student's program adviser along with an official transcript and a course description. Grades on transfer credits may not be used in obtaining the academic average necessary for completion of degree requirements.

Time Limitations

Course credits earned in the graduate study program or accepted by transfer are valid for a maximum of six years from the date of course completion unless an extension is granted by the College Graduate Committee.

Comprehensive Examination

A comprehensive subject-matter examination is taken by each candidate no later than two weeks before his commencement. This examination may be taken when the candidate has completed at least three-fourths of the designated course work, and received consent of his program adviser. The comprehensive examination is prepared by selected graduate faculty with whom the student has studied. The areas to be tested are commensurate with the student's specialization, area of concentration, and core subject matter appropriate to his professional field. The program adviser makes arrangements for the preparation of the test. Faculty members preparing the examination assume responsibility for its reading and grading, and for informing the adviser of results. Test results are reported by the program adviser to the Director of the Boston-Bouvé College Graduate School.

Each section of the examination is graded on the basis of A, B, C, or F. The candidate's total grade must average to the grade of B. Grades of F are not acceptable. A student failing all or part of the examination may, upon the recommendation of his adviser, be given one re-examination. Conditions governing re-examination are determined by the Director of the Graduate School or an appropriate designate.

Thesis

Each candidate must submit a thesis which clearly exhibits his research ability, and is designed to increase the scope of his individual specialization. The thesis proposal is submitted to the program adviser for approval. Upon initial approval, a thesis adviser and two additional committee members are appointed by the Director of the Graduate School at the recommendation of the program adviser. The thesis proposal and completed thesis must be approved by the thesis committee and the Director of the Graduate School.

financial information

FINANCIAL OBLIGATIONS

Tuition

Tuition rates and fees are subject to revision by the Board of Trustees at any time. However, any change in tuition and fees will become effective at the beginning of the school year which follows the one in which the change was announced. Tuition for master's degree candidates and special students is \$45 per quarter hour of credit.

Tuition statements are mailed to students by the Bursar's Office and are payable by check to Northeastern University on or before the date specified.

Fees

All applications must be accompanied by a nonrefundable application fee of \$15. No application will be processed until the fee has been received by the Graduate School of Boston-Bouv  College. Checks should be made payable to Northeastern University and sent, with the application, to Dr. Barbara Philbrick, 117 Dockser Hall.

Other fees include a charge of \$10 for late payment of tuition; a fee of \$2 for deferred tuition (with approval of Bursar); a final examination make-up fee of \$5; and a fee of \$25 for all degree candidates, payable before commencement by the applicable date listed on the academic calendar.

All part-time students on the Huntington Avenue Campus are charged \$.75 a quarter for the services available in the Student Center.

All financial obligations to the University must be discharged by graduation.

Refunds

Tuition refunds are granted only on the basis of the date appearing on the official withdrawal form filed by the student. Non-attendance does not constitute official withdrawal. Questions regarding refunds should be discussed with the Bursar's Office.

Refunds will be granted in accordance with the following schedule:

Official Withdrawal Filed Within:	Percentage of Tuition Refunded:
First week of quarter	100
Second week	75
Third week	50
Fourth week	25

FINANCIAL AID

There is a limited amount of financial aid for part-time students enrolled in Boston-Bouvé College Graduate School. Graduate assistantships and/or fellowships in the College are not available to part-time students. There are a limited number of teaching assistantships available to qualified full-time graduate students. Assigned duties require 18-20 hours per week for which the student receives a \$2,600 stipend and tuition waiver. Further information and applications may be obtained from the Boston-Bouvé College Graduate Office.

Martin Luther King, Jr., Scholarships

Established in 1969 in memory of the late Rev. Martin Luther King, Jr. Awards are made as openings occur to qualified minority graduate students who show financial need and are accepted to full-time study in the graduate schools of the University. Stipends will cover tuition and all fees.

Dormitory Proctorships

A number of proctorships in men's dormitories on or near the Huntington Avenue Campus are available each year. Appointments carry a minimum compensation of room and board. Further information and application forms may be obtained from the Office of University Housing.

National Direct Student Loan

This program is available to students who are carrying at least one-half the normal academic work load, are accepted as degree candidates, and who show evidence of financial need.

The Federal maximum which a graduate student may borrow while pursuing a post-baccalaureate degree is \$5,000.

Repayment and interest on these loans do not begin until nine months after the student ceases to carry at least a half-time academic load at an institution of higher education. The repayment of principal may be extended over a 10-year period with the interest at the rate of three percent per annum. Repayment may be deferred up to a total of three years while a borrower is serving as a Peace Corps or VISTA volunteer.

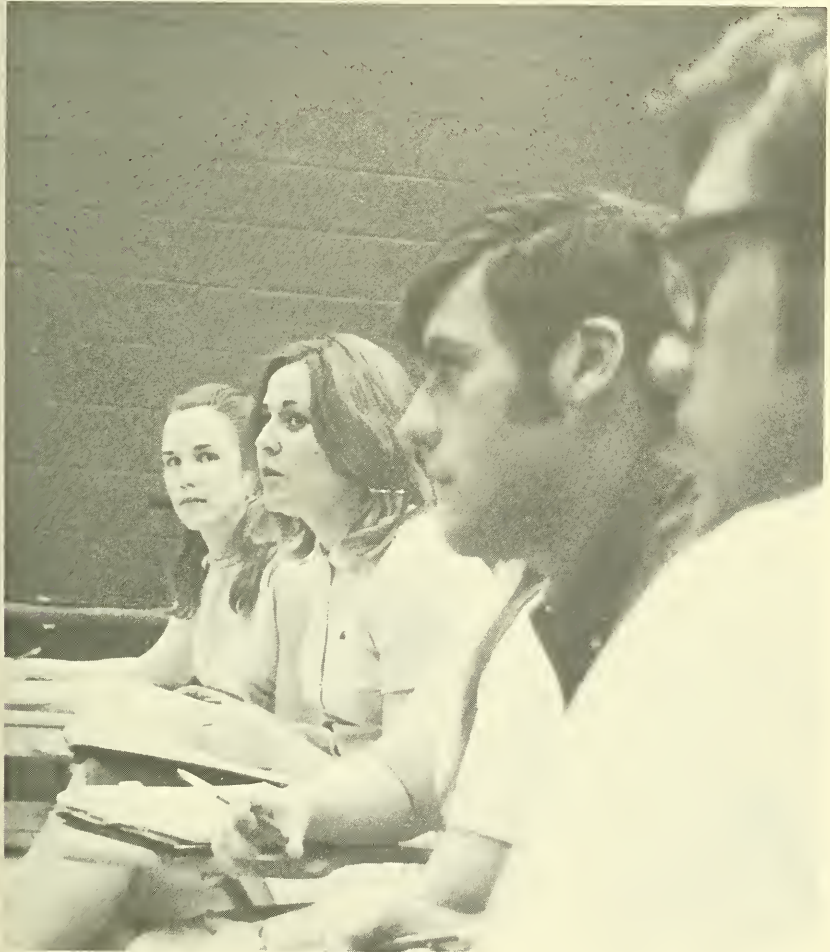
Guaranteed Student Loan Program

Under this program, students who are matriculated degree candidates, enrolled for at least one-half the normal academic work load, may borrow from a participating bank or other financial institution. Terms and conditions vary from state to state, but a student generally may borrow up to \$1,500 a year (the law allows a maximum of \$2,500 per year) de-

pending on financial need. The Federal government pays the interest while the student is in school if the student is eligible for interest subsidy.

The student must have submitted, through the College Scholarship Service, a Parents' Confidential Statement; or if he has been declared financially independent by the Financial Aid Office, a Students' Confidential Statement. These forms are available in the Financial Aid Office.

Applications for the loan itself are available from local banks or the Education Office of your state government. Additional information and necessary application forms for Massachusetts residents are available from the Financial Aid Office.





faculty

GRADUATE TEACHING FACULTY OF BOSTON-BOUVÉ COLLEGE

- Allen, Catherine L., B.S., M.A., Ed.D., Ph.D., *Dean of Boston-Bouvé College. Director of Boston-Bouvé College Graduate School, and Professor of Health, Physical Education and Recreation*
- Carlisle, Katherine, A.B., *Professor of Physical Therapy and Chairman of the Department; Lorraine C. Snell Professor in Health Care (1973-75)*
- Christensen, Carl S., B.S., M.S., Ph.D., *Professor of Physical Education and Chairman of the Department*
- Curtis, Joseph, B.S., M.S., *Visiting Lecturer in Recreation Education*
- Fox, John W., A.B., M.A., Ed.D., *Professor of Physical Education*
- Garrity, H. Marie, B.S.Ed., Ed.M., Ed.D., *Associate Professor of Health Education and Executive Officer of the Department*
- Jeffrey, Howard, A.B., M.A., D.R., *Associate Professor of Recreation Education*
- Kassabian, Kerkor, B.S., Ed.M., *Associate Professor of Physical Education*
- Luttgens, Kathryn, B.S., M.S., Ph.D., *Professor of Physical Education*
- McCay, Albert H., B.A., M.A., Ed.D., *Professor of Recreation Education and Chairman of the Department*
- McKenney, Joseph, A.B., M.A., Ed.M., *Visiting Lecturer in Physical Education*
- Morrison, Richard, B.A., M.S., Ed.D., *Associate Professor of Recreation Education*
- Philbrick, Barbara, B.A., M.S.Ed., Ph.D., *Associate Professor of Physical Education*
- Robinson, Frank, B.A., M.S., *Associate Professor of Recreation Education*
- Robinson, Sarah, B.S., M.S., *Associate Professor of Physical Education*
- Rowlands, Jeanne L., B.A., B.S., M.A., *Associate Professor of Physical Education*
- Sayed, Alae-Eldin, B.S., M.S., Ed.D., *Assistant Professor of Recreation Education*
- Shaffer, Kathryn, J., B.S., M.S., *Professor of Physical Therapy and Coordinator of Clinical Education*
- Vanderpool, Kenneth G., B.A., M.Ed., Ed.D., *Assistant Professor of Physical Education*
- Van Slyck, Elizabeth W., B.S., M.A., *Professor of Physical Therapy and Associate Chairman of the Department*
- Zobel, Richard C., B.S., M.A., Ed.D., *Professor of Physical Education*

fields of study

PROGRAMS IN PROFESSIONAL SPECIALIZATIONS Master of Science

Description

All students must complete one of the programs as outlined in the following pages. In almost all cases the sequence is designed to be very flexible. Any variations or changes must have the prior recommendation of the student's program adviser and approval of the Boston-Bouvé College Graduate School Director.

Core Courses Required of All Candidates

50.841 Introduction to Educational Statistics

66.802 or 50.815 Research Design in Physical Education and Recreation Education

66.890 Thesis I

66.891 Thesis II

Competency, as demonstrated by the successful completion of a proficiency examination, is accepted in lieu of Statistics and/or Research Design. The candidate must petition the Director of Boston-Bouvé College Graduate School for permission to attempt the proficiency examination. An elective course must be substituted for a core course which has been waived.

Specialization in Physical Education

For a specialization in Physical Education, 20 quarter hours of departmental courses are required. Eight quarter hours are selected from foundation courses taken within Boston-Bouvé College and 12 quarter hours from one of the four areas of concentration. In addition, 12 quarter hours of free elective courses appropriate to the student's program are selected from within Boston-Bouvé College or from other Colleges at Northeastern University. Foundation electives, areas of concentration, and the courses therein follow.

Foundation Electives within Boston-Bouvé College

62.870 Philosophies in Physical Education

62.872 Comparative Physical Education

62.874 Seminar in Issues and Trends in Education

62.875 Perspectives in Graduate Education

62.886 Critical Thinking and Evaluation in Physical Education

Areas of Concentration

Area I — Administration and Supervision

- 62.810 Administration in Physical Education
- 62.812 Development and Maintenance of Facilities
- 62.814 Supervision in Physical Education
- 62.820 Athletic Administration
- 62.822 Problems in Contemporary Athletics for Men and Women

Area II — Curriculum and Instruction

- 62.830 Curriculum Development
- 62.833 Applied Evaluation in Curriculum and Instruction
- 62.835 Seminar in Curriculum and Instruction
- 62.840 Advances in Instructional Concepts
- 62.842 Physical Education for the Atypical Child
- 62.884 Movement and the Learning Process

Area III — Development and Learning in Movement and Perception

- 62.842 Physical Education for the Atypical Child
- 62.860 Early Childhood Movement Patterns
- 62.864 Perceptual Motor Development
- 62.884 Movement and the Learning Process
- 66.894 Independent Study (Movement Education Laboratory)

Area IV — Sports Medicine (non-clinical)

- 62.851 Anatomic Kinesiology
- 62.852 Mechanical Analysis of Sport
- 62.854 Physical Fitness Appraisal and Guidance
- 62.857 Trauma Diagnosis and Treatment in Sport
- 62.859 Rehabilitation from Injury in Sport
- 62.880 Sociology of Sport
- 62.882 Psychology of Coaching and Sport

Specialization in Recreation Education

To specialize in Recreation Education, four quarter hours of departmental course work are required. Each candidate is registered for either 63.812, Seminar in Contemporary Issues and Problems in Recreation Services or 63.830, Organization and Administration of Recreation Services. In addition, seven courses (28 quarter hours) appropriate to the student's needs and professional objectives are selected from the following list:

Community Recreation

- 63.834 Programs in Recreation
- 63.840 Recreation, Politics, and Bureaucracy
- 63.842 Recreation and the Community School
- 63.844 Leisure and Delinquent Behavior

Therapeutic Recreation

- 63.850 Introduction to Therapeutic Recreation Services
- 63.852 Recreation Services for Ill, Disabled, and Aging Persons
- 63.854 Observation of Recreation Services in Treatment Settings
- 63.856 Seminar in Outdoor Education for the Handicapped

Outdoor Education

- 63.824 School Camping
- 63.826 Administration of Resident Camp Programs
- 63.856 Seminar in Outdoor Education for the Handicapped

General Recreation Courses

- 63.810 Seminar in Literature and Research in Recreation
 - 63.814 Grantsmanship
 - 63.816 Management Information Systems
 - 63.836 The Marketing of Recreation
 - 63.838 Planning and Developing Recreation Facilities
 - 66.894 Independent Study in Recreation Services
- Selected Interdisciplinary Courses

Electives Offered by Boston-Bouvé College

- 66.899 Seminar/Workshop
- 66.901 Health Issues: Implications for Education
- 66.902 Toward Accountable Health Curriculum
- 66.903 Teaching Strategies: School and Community Health Education
- 66.904 Contemporary World Health
- 66.905 Environmental Health
- 66.906 Consumer Health

courses

DESCRIPTION OF COURSES

All courses carry four quarter hours of credit unless indicated otherwise. Please see the current brochure for summer, fall, winter, and spring quarter course offerings.

PHYSICAL EDUCATION

62.810 Administration of Physical Education

Exploration of principles and practices applied to elementary, junior, and senior high schools, and college physical education programs. Emphasis is placed on the interrelationship between education and physical education. Problems of personnel management, legal aspects, class scheduling, budgeting, and other administrative concerns are discussed.

Fall 1974

62.812 Development and Maintenance of Facilities

Consideration of principles, terminology, and standards for planning, construction, use, and maintenance of outdoor and indoor physical education and recreation facilities.

Spring 1975

62.814 Supervision in Physical Education

An investigation of the interpersonal relationships which effect improved instruction in physical education. Emphasis is placed on selected aspects of personality and human dynamics, job analysis, and teaching effectiveness, processes effecting change, and current problems in supervision.

Winter 1975

62.820 Athletic Administration

Standards and principles connected with the conduct of school and college athletics for both men and women. The course is intended to aid those persons responsible for both intramural and interschool athletic programs. Consideration is given to the welfare of participants, public relations, contracts, scheduling, conduct of tournaments, officials, and awards.

Summer 1975

62.822 Problems in Contemporary Athletics for Men and Women

Current problems, practices, and national issues pertinent to the conduct of athletic competition. National, state, and conference organizations are studied.

Winter 1976

62.830 Curriculum Development in Physical Education

The theory, practice, research, and evaluation of curriculum and curricular processes in American education. Special emphasis is placed upon elementary and secondary school programs of physical education and innovation in curricular designs. Fall 1975

62.833 Applied Evaluation in Curriculum and Instruction

A practical approach to the application of current educational evaluation theory to concepts of instruction and curriculum development. Includes formative and summative techniques applied for the improvement of instruction, assessment of product and process in the educational program, and teacher/learner interaction analysis. *Prep. 62.830, Curriculum Development or equivalent.* Spring 1976

62.835 Seminar in Curriculum and Instruction

Problems of special interest in instructional theory, curriculum theory, and applied evaluation theory. Practical papers and class presentations emphasize scholarship in the solution of educational problems or issues. *Prep. two courses from the Curriculum and Instruction concentration.* Summer 1975

62.840 Advances in Instructional Concepts

Current practices in and a search for new approaches to all levels of instruction in physical education. Includes analyses of team teaching, the master teacher plan, programmed instruction, videotaped feedback, and other instructional aids and techniques. Winter 1976

62.842 Physical Education for the Atypical Child

An investigation of techniques, equipment, methods, and graded programs for atypical children. Spring 1975

62.851 Anatomic Kinesiology

A study of the human musculo-skeletal system and its relationship to human movement patterns. Electromyography is used in assessing muscle-movement relationships. Current electromyographic research and techniques are investigated. Fall 1975

62.852 Mechanical Analysis of Sport

Application of mechanics of motion to the analysis of human motion. Emphasis is placed on cinematography and film analysis procedures in teaching and research. *Prep. 62.851, Anatomic Kinesiology or permission of instructor.* Spring 1976

62.854 Physical Fitness Appraisal and Guidance

Physical fitness tests, developmental and rehabilitation programs, low-fitness groups, fitness-producing activities, and current trends in testing and research. *Prep. Physiology and Measurement and Evaluation, or permission of instructor.* Summer 1975

62.857 Trauma Diagnosis and Treatment in Sport

An investigation of injury pathology, evaluative testing, diagnosis, and appropriate treatment modalities. *Prep. undergraduate Athletic Training or experience.* Spring 1976

62.859 Rehabilitation from Injury in Sport

Rehabilitation procedures and techniques appropriate to the post-injury retraining of athletes. *Prep. Adapted Physical Education or permission of instructor.* Summer 1974

62.860 Early Childhood Motor Patterns

The sequential development of fundamental motor patterns from age zero to 10 years. How to observe youngsters in a movement situation and assess their motor patterns. Fall 1974

62.864 Perceptual-Motor Development

An overview of major theories of learning and perception as they apply to learning and refining motor skills. The interrelationships of movement behavior and perceptual-motor organization of vision, audition, proprioception, kinesthesia, and psycho-social effects are studied. Winter 1975

62.870 Philosophies in Physical Education

An exploration of major philosophies, past and present, and their influence on modern physical education. The student delineates his personal philosophy, explores philosophical analysis as a research technique, and reviews philosophical research. *Prep. Philosophy, Philosophy of Education, or permission of instructor.* Spring 1975

62.872 Comparative Physical Education

Both past and present philosophies and practices of national and international programs in physical education are compared. Historical analysis is introduced as a research technique. Summer 1974

62.874 Seminar in Issues and Trends in Education

Analysis of current issues and trends in education and physical education, with emphasis on systematic and practical solutions, resolutions, and adaptations. Spring 1976

62.875 Perspectives in Graduate Education

Introduction to goals of graduate education study and research; their history, standards, and operating codes. The dimensions of and preparation for academic and professional disciplines, dimensions of science and the scientific method, professional and scientific research, scientific writing, and thesis format. Summer 1975

62.880 Sociology of Sport

An analysis of the sociological principles and factors operative in the interaction between sport and society. Pertinent literature and research

are reviewed. *Prep. General Sociology or permission of instructor.*

Winter 1975

62.882 Psychology of Coaching and Sport

Group dynamics, leadership, and mental and emotional values of sport. Emphasis is placed on stress, maturation, motivation, and learning as each relates to the teacher and participant. *Prep. General Psychology or permission of instructor.*

Winter 1976

62.884 Movement and the Learning Process

Major theories and research in learning and their application to learning motor skills. Perceptual-motor development and learning are examined; the programs evolving in this area and their implications for the teaching-learning process of motor skills are presented. *Prep. Educational Psychology or permission of instructor.*

Summer 1974

62.886 Critical Thinking and Evaluation in Physical Education and Recreation Education

Investigation of various approaches to the acquisition of knowledge and evaluation processes. Included are experiences in decision-making, logical and critical thinking, and test analysis.

Fall 1974

RECREATION EDUCATION

63.812 Seminar in Contemporary Issues and Problems in Recreation Services

Discussion of national and international issues, current trends, and contemporary problems as they affect recreation services.

Winter 1975

63.814 Grantsmanship

A seminar in which the student develops a grant proposal for submission to a funding source of his choice. Government and foundation grant programs are explored.

Fall 1974

63.816 Management Information Systems

The process of gathering, storing, and retrieving data for the purpose of making timely, accurate, organizational decisions. Emphasis is placed on decision-making in the areas of budget, service delivery, and staff effectiveness. Where appropriate, the systems are adapted for computer use at the community or agency level. Neither a mathematics nor computer background is necessary.

Winter 1975

63.824 School Camping

An independent study of the nature and conduct of outdoor recreation education as implemented in school camping programs. Problems investigated and methods developed under supervision of the faculty adviser and staff.

Spring 1975

63.826 Administration of Resident Camp Programs

An in-depth study of staffing, sanitation and health; purchasing and storage of food, materials, equipment, and supplies; kitchen management; insurance, construction, and maintenance of buildings; and program areas as they affect resident camping programs. A study of nationwide aims and trends in the camping movement is included. This course is conducted at Warren Center, Ashland, Massachusetts, as an intensive, residential, one-week workshop during the March quarter interim. 1975

63.830 Organization and Administration of Recreation Services

Patterns for the implementation of recreation service by school systems, voluntary agencies, national service organizations, municipal governments, and state and Federal agencies investigated in depth. Fall 1974

63.834 Programs in Recreation

An examination and evaluation of program content, leadership, administration, and facilities in recreation service, sponsored under public, private, religious, industrial, and voluntary auspices. Summer 1974, 1975

63.836 The Marketing of Recreation

Methods by which the underlying rationale and values of recreation can be effectively communicated to the public. Emphasis is placed on documenting the values of recreation. Spring 1975

63.838 Planning and Developing Recreation Facilities

The development by each student of a master plan for recreation in a city or town. Integrated planning among all municipal departments is stressed. Summer 1974, 1975

63.840 Recreation, Politics, and Bureaucracy

Practical problems faced by recreation professionals in public service are investigated. Students study relationships between elected officials, bureaucrats, peers, subordinates, and supervisors in state and local governments. Summer 1974, 1975

63.842 Recreation and the Community School

The concept of the role of recreation in community schools studied in depth. School visitation provides insight and discussion related to the characteristics, needs, programming, evaluation, and problems of various community schools. Spring 1975

63.844 Leisure and Delinquent Behavior

Recreation studied as an intervention strategy to prevent and rehabilitate delinquent behavior. Fall 1974

63.850 Introduction to Therapeutic Recreation Services

The type, nature, cause, and prognosis of different disabilities. The impact of disability on the individual, his family, and community, and the role of therapeutic recreation programs in rehabilitation are discussed.

Fall 1974

63.852 Recreation Services for Ill, Disabled, and Aging Persons

A study of recreation services in relation to progressive patient-care patterns; limitations on activity participation imposed by impairment or disability; effect of activity participation on these people. *Prep.* 63.850.

Winter 1975

63.854 Observation of Recreation Services in Treatment Settings

A guided observation under supervision of resident administrators in a clinical setting. Individual and group conferences are held with the instructor, and reports and readings assigned based on observations.

Spring 1975

63.856 Seminar on Outdoor Education for the Handicapped

A practical approach to outdoor education programs appropriate for the disabled who lack the advantage of summer programs. Experiences, activities, natural resources, and environmental conditions which relate to outdoor education are investigated.

Summer 1974, 1975

INTERDEPARTMENTAL COURSES

50.841 Introduction to Educational Statistics

Basic statistical techniques such as measures of central tendency, variability, probability, correlation and regression, chi square, t test, and analysis of variance are covered. This course is conducted by the Graduate School of Education in the College of Education.

All Quarters

66.802 Research Design

Research methods and designs used in health, physical education, and recreation education, with emphasis on critical reading and understanding of research material. *Prep.* 50.841, or permission of instructor.

Winter and Summer Quarters

66.890 Thesis I

Initiation of a scholarly investigation under the auspices of the appropriate department. A written research proposal submitted to and approved by the student's thesis committee. *A student must have the permission of his program adviser before registering for this course.*

66.891 Thesis II

The investigation proposed in Thesis I implemented with and culminated in an approved written report in thesis form. In partial fulfillment of this

requirement, the student attends a series of research seminars. Upon completion, the candidate presents his thesis orally before the College seminar group. *Eight quarter hours for Thesis I and Thesis II.*

66.894 Independent Study in Physical Education or Recreation Education

Under the guidance and direction of his program adviser, each student develops and conducts a small project related to his professional interest which includes: a statement of problem or purpose, hypothesis, an exhaustive review of literature, an appropriate research design; a standard investigating instrument or one of his own design, a small sample of the population subjected to investigation, presentation and discussion of results, and a statement of conclusions. The project is reported in thesis format when appropriate. (Credit arranged with program adviser.) *Prep. permission of program adviser.*

66.899 Seminar/Workshop

The College may offer a special seminar or workshop from time to time in health, physical education, physical therapy, or recreation. Graduate credit may be granted for successful completion of a workshop, but credit may not be applied toward a degree program without the approval of the program adviser. All participants must be degree candidates in the Boston-Bouvé Graduate Program or must qualify, prior to registration, as special graduate students. Credit of one, two, three, or four quarter hours is determined by the workshop director. *Prep. permission of workshop director.*

66.901 Health Issues: Implications for Education

Identification and analysis of today's critical health issues. Increased educational involvement to fill the gap between current health knowledge and overt behavior.

66.902 Toward Accountable Health Curriculum

Exploration, assessment, and analysis of the professional team and selected health curriculum. Involvement of current educational philosophy to strengthen the ultimate goal of producing humane individuals by accountable health curriculum.

66.903 Teaching Strategies: School and Community Health Education

Essential contemporary strategies for achieving a humanizing base to reduce the time lag between relevant health information, action, values, and the modification of health behavior regarding school and community health education. Selected student projects in developing models for personal concerns.

66.904 Contemporary World Health

A survey of the state of the world's health, the progress which has been made, and the difficulties yet to be overcome. The importance of "partners in health," as compared to the solitary research worker, in reaching the current health needs. The contributions of WHO, UNESCO, UNICEF, and FAO.

66.905 Environmental Health

The study of some of the most serious problems facing mankind as man continues to pollute and ravage his environment. Student involvement in selected problem areas associated with air, water, and noise pollution; solid waste accumulation; and the use of pesticides and other pollutants.

66.906 Consumer Health

Analysis and evaluation of the concepts concerned with the careful selection of health products and services. Decision making relative to the selection of health products and services; evaluating advertising; quackery; protection against useless or dangerous products through consumer organizations as areas for student exploration and study projects.

index

A

Academic Council, 13
Academic Requirements, 28
Address of Boston-Bouvé College
 Graduate School, 1
Administration
 Graduate Schools, 14
 University, 10
Admission to Degree
 Candidacy, 27
Apartments, Graduate Students, 22
Application for Diploma, 27

B

Board of Trustees, 9
Brockton, Nashua, and
 Framingham Campuses
 (M.B.A. Program), 23
Buildings and Facilities, 21

C

Cabot Physical Education
 Center, 22
Calendar, 5
Campus Description and
 Location, 21
 Map, 4
Changes in Requirements, 27
Class Hours and Credits, 26
Classifications, Academic, 28
Colleges, Undergraduate, 19
Committee of Boston-Bouvé
 College Graduate School, 18
Comprehensive Examination, 30
Continuing Education, Center
 for, 20

Continuity of Program, 27
Cooperative Plan of Education, 19
Core Requirements, 36
Corporation, 7
Courses, Description of
 Interdepartmental, 44
 Physical Education, 39
 Recreation Education, 42
Credits, 26
 Transfer, 29

D

Diploma, Application for, 27
Dockser Hall, 22
Dormitory Proctorships, 32

E

Electives Offered by
 Boston-Bouvé College, 38
Equal Opportunity Policy, 6
Examination, Comprehensive, 30
Executive Committee (Trustees),
 10

F

Faculty, 35
Faculty Senate, 14
Fees, 31
Fields of Study
 Physical Education, 36
 Recreation Education, 37
 Programs in Professional
 Specializations, 36
Financial Aid, 32
Financial Obligations, 31

G

Grading System, 25
Graduate and Professional
Schools, 19
Graduate Committee,
Boston-Bouvé, 18

H

Henderson House, 23
Holidays, University, 6

I

Interdepartmental Courses, 44

L

Libraries, 21
Loans, 32

M

Map of Campus, 4
Marine Science Institute, 23
Master's Degree, Admission, 27

N

National Direct Student Loan, 32

P

Part-Time Study, 25
Proctorships, Dormitory, 32
Program Selection, 29

R

Refunds, 31
Registration, 24
Dates, 5
Regulations, 25
Requirements, Changes in, 27
Research Activities, 20
Residence Requirements, 24

S

Scholarships, Martin Luther
King, Jr., 32
Specializations
Physical Education, 36
Recreation Education, 37
Student Center, 20
Suburban Campus, 22

T

Thesis, 30
Time Limitations, 30
Transfer Credits, 29
Trustees, 9
Tuition, 31

U

Undergraduate Colleges, 19
University Executive Council, 13
University Graduate Council, 15

W

Warren Center, 23
Withdrawals, 27



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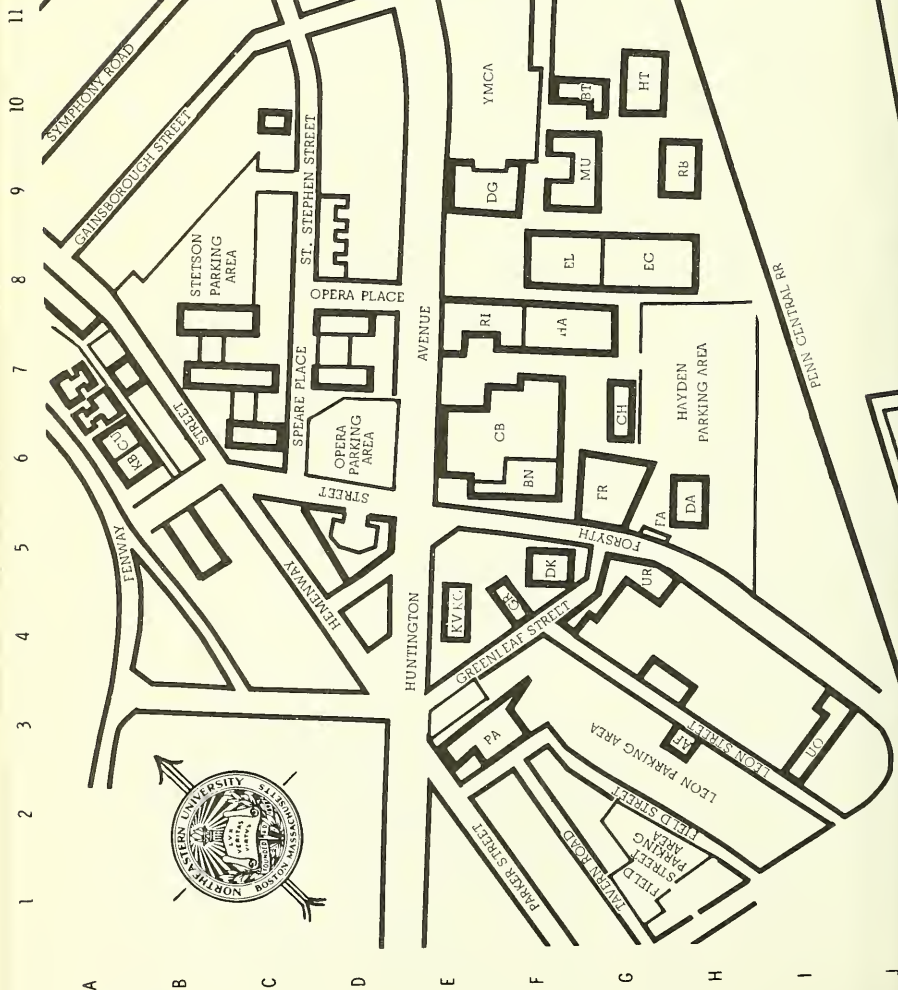
Northeastern University
214 Hayden Hall
360 Huntington Avenue
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Graduate School of Engineering 1974-76



contents

4	Campus Map
5	Academic Calendar
6	University Holidays
7	The Governing Boards and Officers of the University
7	The Northeastern University Corporation
9	Board of Trustees
11	Administration Organization
13	General University Committees
14	Organization of the Graduate Schools
19	The University
21	Buildings and Facilities
25	Regulations of the Graduate School of Engineering
25	General Regulations
31	The Master's Degree
33	The Doctor of Philosophy Degree
36	The Doctor of Engineering Degree
38	Interdisciplinary Programs
40	The Engineer Degree
43	Financial Information
43	Financial Obligations
44	Financial Aid
47	Faculty
51	Fields of Study
51	Civil Engineering
60	Mechanical Engineering
69	Electrical Engineering
83	Chemical Engineering
89	Industrial Engineering and Engineering Management
97	Description of Courses
97	Civil Engineering
108	Mechanical Engineering
121	Electrical Engineering
142	Chemical Engineering
146	Industrial Engineering and Engineering Management
155	Mathematics and Physics
157	Index



MAP REFERENCE

F6
F10
E6
G7
A6
H6
F5
E9
G8
F8
G6
G5
F4
F7
G10
B6
E4
E4
J3
H3
F9
F3
E7
H9
G5

Building Designation

BN Barletta Natatorium
BT Botolph Building
CB Cabot Physical Education Ctr.
CH Church Hill Hall
CU Cushing Hall
DA Dana Research Center
DK Dockser Hall
DG Dodge Library
EC Eli Student Center and Alumni Auditorium
EL Forsyth Building
FR Forsyth Building Annex
FA Greenleaf Building
GR Hayden Hall
HA Hurtig Hall
HT Kennedy Building
KB Knowles Center (Volpe)
KV Knowles Center (Gryzmish)
KG 11 Leon Street
UO Afro-American Institute
AF Mugar Life Sciences Building
MU Parker Building
PA Richards Hall
RI Robinson Hall
RB United Realty Building
UR

ACADEMIC CALENDAR 1974-1975

Fall Quarter 1974

Registration period (1:00-3:00 and 5:30-8:00 p.m.)		
Burlington	Tuesday-Wednesday	Sept. 17-Sept. 18
Boston	Monday-Thursday	Sept. 23-Sept. 26
Interview period for new students by appointment*		
	Wednesday-Thursday	Sept. 18-Sept. 26
Classes begin	Monday	September 30
Last day to drop a course	Saturday	November 27
Examination period†	Monday-Friday	Dec. 16-Dec. 20

Winter Quarter 1974-1975

Registration period (1:00-3:00 and 5:30-8:00 p.m.)		
Burlington	Tuesday	December 3
Boston	Monday-Thursday	Dec. 9-Dec. 12
Interview period for new students by appointment*		
	Monday-Thursday	Dec. 9-Dec. 12
Classes begin	Monday	January 6
Last day to drop a course	Saturday	March 8
Examination period†	Monday-Friday	Mar. 24-Mar. 28

Spring Quarter 1975

Registration period (1:00-3:00 and 5:30-8:00 p.m.)		
Burlington	Tuesday	March 11
Boston	Monday-Thursday	Mar. 17-Mar. 20
Classes begin	Monday	April 7
Last day to file commencement card for spring commencement		
	Monday	March 31
Last day to pay fee for spring commencement		
	Monday	April 28
Last day to drop a course	Saturday	June 7
Final grades due in Registrar's Office for June graduates taking third quarter course		
	Friday	May 30
Examination period†	Monday-Friday	June 16-June 20
Spring commencement	Sunday	June 22

*Appointments for interviews with new students must be made at least four days before the date of the interview.

†Examinations for day classes will be held in accordance with the undergraduate examination schedule.

Summer Quarter 1975

Registration period (5:30-8:00 p.m.)

Burlington	Monday-Tuesday	June 16-June 17
Boston	Wednesday-Thursday	June 18-June 19

Interview period for new students by
appointment

Monday-Thursday June 16-June 19

Classes begin

Monday June 30

Last day to file a commencement

card for fall commencement Tuesday July 1

Examination period

Wednesday-Friday Aug. 6-8

Last day to pay fee for

fall commencement Wednesday July 30

UNIVERSITY HOLIDAYS 1974-1975

Columbus Day	Monday	October 14
Veterans' Day	Monday	October 28
Thanksgiving Recess	Thursday-Saturday	Nov. 28-Nov. 30
Christmas Vacation	Monday-Saturday	Dec. 23-Jan. 4
Washington's Birthday	Monday	February 17
Patriots' Day	Monday	April 21
Memorial Day	Monday	May 26
Independence Day	Friday	July 4
Labor Day	Monday	September 1

Equal Opportunity Policy

Northeastern University is committed to a policy of providing equal opportunity for all. In all matters involving admission, registration, and all official relationships with students, including evaluation of academic performance, the University insists on a policy of nondiscrimination. Northeastern University is also an equal opportunity employer; it is institutional policy that there shall not be any discrimination against any employee or applicant for employment because of race, color, religion, sex, age or national origin. In addition, Northeastern takes affirmative action in the recruitment of students and employees.

the governing boards and officers of the university

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the university

Founded in 1898, Northeastern University is incorporated as a privately endowed nonsectarian institution of higher learning under the General Laws of Massachusetts. The State Legislature by special enactment has given the University general degree-granting powers. The University is governed by a Board of Trustees elected by and from the Northeastern University Corporation, which is composed of nearly 180 distinguished business and professional men and women.

From its beginning, Northeastern University has had as its dominant purpose the discovery of community educational needs and the meeting of these in distinctive and serviceable ways. The University has not duplicated the programs of other institutions, but has sought to pioneer new areas of educational service.

A distinctive feature of Northeastern University is its Cooperative Plan, initiated by the College of Engineering in 1909 and subsequently adopted by the Colleges of Business Administration (1922), Liberal Arts (1935), Education (1953), Pharmacy (1962), Nursing (1964); Boston-Bouvé College (1964); the College of Criminal Justice (1967); and by Lincoln College's daytime Bachelor of Engineering Technology program (1971). This educational method enables students to gain valuable practical experience as an integral part of their college program and also provides the means by which they may contribute substantially to the financing of their education. The Plan has been extended to the graduate level in engineering, actuarial science, rehabilitation administration, professional accounting, business administration, and law.

In the field of adult education, programs of study have been developed to meet a variety of needs. University College offers evening courses — offered by the University since 1906 — and adult-day courses leading to the bachelor's degree. In addition to offering day undergraduate programs in Electrical Engineering Technology and Mechanical Engineering Technology, Lincoln College offers evening/part-time certificate, associate, and bachelor degree programs in technological areas. All formal courses of study leading to degrees through part-time programs are approved by the Basic College faculties concerned.

GRADUATE AND PROFESSIONAL SCHOOLS

The ten graduate and professional schools of the University offer day and evening programs leading to the degrees listed.

The Graduate School of Actuarial Science offers the degree of Master of Science in Actuarial Science.

The Graduate School of Arts and Sciences offers the degrees of Master of Arts, Master of Science, Master of Science in Health Science, Master of Public Administration, and Doctor of Philosophy.

The Graduate School of Boston-Bouv   College offers the degree of Master of Science.

The Graduate School of Business Administration offers the degree of Master of Business Administration.

The Graduate Program in Criminal Justice offers the degree of Master of Science.

The Graduate School of Education offers the degree of Master of Education and the Certificate of Advanced Graduate Study.

The Graduate School of Engineering offers the degrees of Master of Science, Engineer degree, Doctor of Engineering, and Doctor of Philosophy.

The School of Law offers the degree of Juris Doctor.

The Graduate School of Pharmacy and Allied Health Professions offers the degrees of Master of Science and Doctor of Philosophy.

The Graduate School of Professional Accounting offers the degree of Master of Science in Accounting.

CENTER FOR CONTINUING EDUCATION

The Center for Continuing Education was established in 1960 to relate the University to the needs of its community in a period of accelerated change. Adult education programs offered by the Center and University College have since been consolidated. Its programs are composed of seminars, conferences, institutes, forums, and a wide variety of special courses designed to serve specific needs. The Division of Special Programs, working cooperatively with trade associations and professional societies, offers a wide variety of programs dealing with current needs and problems. Through its Division of Community Services, working with governmental agencies and community organizations, the Center is becoming increasingly involved in social problems on both the local and national level.

Many of these programs are conducted at Henderson House, Northeastern University's conference center in Weston, Massachusetts.

RESEARCH ACTIVITIES

The facilities of the University are engaged in a wide variety of basic research projects in business, science, social science, pharmacy, and engineering. These are coordinated by the Dean of Research, whose services are University-wide and available to the faculties of all the Colleges.

Although Northeastern is primarily concerned with undergraduate and graduate instruction, the University believes that the most effective teaching and learning takes place in an environment characterized by research activities directed toward extending the frontiers of knowledge.

buildings and facilities

MAIN CAMPUS

The main campus of Northeastern University is located at 360 Huntington Avenue in the Back Bay section of Boston. Many of the city's famous cultural, educational, and philanthropic institutions are situated in the Back Bay, including the Museum of Fine Arts, Symphony Hall, Horticultural Hall, the Isabella Stewart Gardner Museum, the Harvard teaching hospitals, the Boston Public Library, and many schools and colleges. Most are within walking distance of Northeastern University.

Major transportation facilities serving the Boston area are Logan International Airport, two rail terminals, bus terminals serving inter- and intrastate lines, and MBTA subway-bus service within the metropolitan-suburban area. There is a subway stop in front of the campus. For motorists, the best routes to the campus are the Massachusetts Turnpike (Exit 22) and Route 9, of which Huntington Avenue is the intown section.

The campus of 48 acres is divided by Huntington Avenue, with the main educational buildings on one side and dormitories on the other. The principal buildings, all of which have been constructed since 1938, are of glazed brick in contemporary classic style. Most are interconnected by underground passageways.

Ell Student Center

The Carl S. Ell Student Center provides facilities for student recreation and for extracurricular activities. The Alumni Auditorium, with a seating capacity of 1,300, is part of the Center. Also included are special drama facilities, a ballroom, main lounge, fine arts exhibition area, student offices, conference rooms, and a dining area seating more than 1,000.

Libraries

The University library system consists of the Dodge Library, which is the main library; the Suburban Campus Library at Burlington; the School of Law Library; and divisional libraries for Physics and Electrical Engineering, Chemistry and Biology, Mathematics and Psychology, Health, Physical and Recreation Education, and Physical Therapy. There are additional subject collections for the Center for Management Development at Andover, Massachusetts, and the Marine Science Institute in Nahant.

The library collections number 360,000 volumes supplemented by some 267,000 titles in microprint, microfilm, and microfiche forms. The collection includes, in addition, some 3,500 periodical titles, 90,000 documents, and 4,600 sound recordings.

Cabot Physical Education Center

The Godfrey Lowell Cabot Physical Education Center is one of the best equipped in New England. It contains four basketball courts, an athletic cage, a women's gymnasium, and a rifle range, as well as administrative offices for the Department of Athletics and for the Physical Education Department of Boston-Bouvé College.

A recent addition to the center, the Barletta Natatorium, houses a 105-foot swimming pool, a practice tank for the crew, handball courts, and shower and dressing facilities.

Dockser Hall

Charles and Estelle Dockser Hall, completed in 1968, houses a large gymnasium, dance studio, motor performance laboratory, college library, community recreation laboratory, folk arts center, dark and music rooms, recreation resources area, locker rooms, offices, classrooms, conference room and lounge, storage facilities, and a research laboratory.

Apartments for Upperclass Students

The University maintains a 100-apartment housing unit which accommodates 279 people. Two-, three-, and four-party apartments are available which vary in size from two to four rooms plus bath. Apartments are furnished with beds, chairs, desks, stove, refrigerator, and kitchen table. The cost includes all utilities.

A \$50 deposit is required when making application for the apartments. Applications are available in the Office of University Housing. Students are expected to make such arrangements on a term-to-term basis but may live in the apartments both while on cooperative work assignments and in school if they wish. All reservations are made on a first-come, first-served basis.

SUBURBAN FACILITIES

Suburban Campus

The Suburban Campus, located near the junction of Routes 128 and 3 in Burlington, Massachusetts, was established to meet the needs of individuals and of industry in the area.

In addition to graduate courses in engineering, physics, mathematics, business administration, science, education, and the arts, portions of undergraduate programs leading to the associate and bachelor's degrees, special programs for adults, and noncredit state-of-the-art programs are offered.

Warren Center

The Warren Center is a practical laboratory for Boston-Bouvé College in outdoor education and conservation, in group practicum, and in camping administration, programming, and counseling. At this Center in Ashland, completed in 1967, there are tennis courts, field hockey and lacrosse fields, waterfront for swimming and boating, overnight camp sites, fields and forests, heated cottages, the Hayden Lodge with a recreation hall, library, crafts shop, dining facilities, and conference accommodations.

Henderson House

The University's conference center, Henderson House, is located in Weston, Massachusetts. The Center for Continuing Education conducts short-term courses, seminars, and special institutes for business, professional, and research groups. Henderson House is 12 miles from the main campus.

Marine Science Institute

The Marine Science Institute at Nahant, Massachusetts, is a research and instructional facility primarily engaged in studies of marine biology and oceanography. The Institute is operated all year, and is about 20 miles northeast of Boston. Many of the courses at this institute are applicable toward an advanced degree in biology or health science.

Government Center Campus

With the cooperation of the Federal Executive Board, the Graduate School of Liberal Arts' Department of Political Science offers an entire Master of Public Administration program at the John F. Kennedy Building in downtown Boston. This program is primarily for individuals employed in Federal, state, or local civil services.

Brockton, Nashua, and Framingham Campuses

For students residing in southeastern Massachusetts and northeastern Rhode Island, the Graduate School of Business Administration offers a significant portion of its M.B.A. Program at facilities in Brockton, Massachusetts. These facilities, made available by the Knapp Corporation, are located on West Chestnut Street in Brockton.

Students residing in the southern New Hampshire area may take a significant portion of the M.B.A. Program at facilities in Nashua, New Hampshire. These facilities are furnished by Sanders Associates, Inc. and are located in their headquarters on Route 3, just over the Massachusetts line.

For students in the Framingham-Worcester area, a significant portion of the M.B.A. Program may be taken at classroom facilities located in Framingham, Massachusetts.



regulations of the graduate school of engineering

The Master of Science degree may be earned in Chemical Engineering, Civil Engineering, Electrical Engineering, Industrial Engineering, Mechanical Engineering, and Engineering Management. In addition, there are programs leading to the Doctor of Philosophy degree in Chemical Engineering, Civil Engineering, Electrical Engineering, and Mechanical Engineering. The Doctor of Engineering degree is offered in Chemical Engineering. The Engineer degree may be earned in Electrical Engineering and Mechanical Engineering.

Cooperative Programs

A unique feature of Northeastern's Graduate School of Engineering is the full-time Cooperative Education Plan. This program adopts the philosophy that a balanced exposure to theory and practice will provide students with a more meaningful education.

All engineering graduate departments offer full-time programs on the Cooperative Plan. The program includes nine months of classroom study and twelve months of work experience in an industrial concern. The cooperative student is able to gain vital experience in a professional environment while also supplementing his tuition payments.

The University has a full-time experienced staff to assist the student in obtaining a cooperative work assignment. The student may also wish to investigate employment opportunities on his own in order to facilitate final placement by the graduate coordinator.

An illustration of term sequence within the two-year Cooperative Education Plan is shown below:

	First Year	Second Year
Fall Quarter	class	work
Winter Quarter	work	class
Spring Quarter	class	work
Summer Quarter	work	

Normally, the Cooperative Plan operates as shown above. Economic conditions, the military, citizenship, and other factors may cause a departure from the normal Plan. Students who are admitted to a masters degree program under the Cooperative Plan must complete, through satisfactory performance, each cooperative work assignment in order to be eligible for their degree.

Engineering Sponsorships (Beginning Academic Year 1975)

Another aspect of Cooperative Education is the Engineering Sponsorship Program. This program provides students with exposure to academic theory and industrial experience. The sponsoring Company, by employing the students during cooperative work quarters, provides a monthly salary for the two (2) year period plus a tuition stipend.

All students who are accepted as full-time cooperative students are considered for Engineering Sponsorships. Notification will be received prior to April 15th if a student has been chosen for a sponsorship. Those students not chosen are still eligible for placement under the Cooperative Plan of Education.

GENERAL REGULATIONS

The general regulations and minimum requirements for all graduate programs are established by the University Graduate Council. In some matters the committee of each graduate school is allowed discretion to establish regulations within limits defined by the council. The regulations and academic requirements which follow have been formulated in accordance with this general policy.

Application Procedures

All applicants for cooperative full-time or continuous full-time study at the master's level should address inquiries to their respective departments or to the Graduate School of Engineering. Application forms and reference blanks will be mailed to the applicant. This material, together with the \$15.00 non-refundable application fee, necessary transcripts, two letters of recommendation, the Graduate Record Examination scores when required, and the results of the Test of English as a Foreign Language (required of all applicants whose native language is not English), should be returned to the Graduate School of Engineering Office as soon after January 15th as possible. The Admissions Committee will notify applicants as soon as their material is complete.

All applicants for part-time study at the master's level should request an application from the Graduate School of Engineering Office. The completed application, the non-refundable \$15.00 application fee and an official transcript should be sent to the graduate school no later than two weeks prior to the interview and registration period for the quarter

in which the applicant plans to begin his program. The dates of the interview and registration periods are announced in the catalog (see academic calendar) and in the circular issued each July. Applicants will be notified by mail regarding acceptance. Mailed applications will be accepted up to two weeks prior to the registration period for the quarter in which the applicant plans to begin the program.

If an applicant is unable to submit the application material by mail at least two weeks prior to the registration period, he should call the Graduate School Office to arrange for a personal interview to determine his qualifications for admission. The application, the non-refundable \$15.00 application fee and the official transcript may be submitted at the interview.

In some cases, the Graduate Record Examination may be required of applicants. The examination is administered by the Educational Testing Service, Box 955, Princeton, New Jersey, 08540. Applicants must make their own arrangements with the Educational Testing Service for the examination.

Test scores for Graduate Record Examinations and Test of English as a Foreign Language sent to the Graduate School of Engineering are retained for only one year from the date they were taken. If an applicant does not enroll in the quarter for which he was accepted, but delays his registration for a period of one year or more from the date that he originally took his examinations, he must repeat the examinations or resubmit the original test scores before he will be permitted to register.

Transcripts

Official transcripts of previous college training must be supplied with the mailed application if an admissions decision is to be rendered by return mail, or submitted at the personal interview. If this is not feasible, the official transcripts must be mailed to the Graduate School of Engineering as soon after the initial registration as possible. Students who have attended institutions outside of the United States should provide comparable certified documents. Failure to file the necessary transcripts will result in the student being asked to withdraw.

Admission

To be admitted for graduate work, an applicant must have obtained a Bachelor of Science degree in engineering or a closely related science from a recognized college or university with an acceptable quality of undergraduate work. His scholastic record, therefore, must show ability to pursue creditably a program of graduate study, and his undergraduate training must indicate breadth as well as adequate preparation in the field in which the applicant expects to do advanced work. Acceptance to the school is granted upon recommendation of the departmental graduate committee or its designate following a review of the applica-

tion and supporting material. The recommendation is based upon promise of academic success and fulfillment of minimum criteria established by each department in the Graduate School of Engineering.

Students with an engineering or related science bachelor's degree, who are enrolled in another graduate school at Northeastern, may transfer to the Graduate School of Engineering. However, they must make application and file the necessary documents, the same as transfers from other colleges or universities. The submission of registration materials for engineering course work does not constitute enrollment in the Graduate School of Engineering.

Registration

Students must register within the dates and times listed on the school calendar. The place of registration will be announced prior to each period.

Auditors are not permitted. All students attending any course in the Graduate School of Engineering must be officially registered by the Registrar and listed on the class roster.

Residence

All work for advanced degrees must be completed at the University unless approval has been obtained from the director of the graduate school for work taken elsewhere. Students who are in residence and are using the facilities of the University must register for such work.

Programs of Study

The curricula of the degree programs are given under each departmental heading. The descriptions of courses offered by the several departments are given so that prospective students may obtain a view of the course coverage. Preparation courses are indicated when necessary. Not all courses are offered every year, but the course offerings will be arranged in such a manner that students may make continuous progress toward the degree.

The Graduate School of Engineering issues a circular close to July 1st which gives the courses for the following academic year and the times at which they meet.

The number of students enrolled in each class will be limited to permit effective teaching at the graduate level. The University reserves the right to cancel, postpone, combine, or modify any course.

At the time of his first registration, each full-time student must develop, with the assistance of his faculty adviser, a complete program of study for the degree for which he is registered. All subsequent changes must be approved by his faculty adviser.

Part-time students will be expected to complete the required courses outlined by each department, after which the elective courses may be

undertaken. The study load for such students is limited to a program of two courses per quarter (one course in the summer) unless special permission to carry a heavier load is given by the director of the graduate school.

Grading System

The performance of students in graduate courses will be recorded by the instructor by use of the following grades:

A Excellent

This grade is given to those students whose performance in the course has been of very high graduate caliber.

B Satisfactory

This grade is given to those students whose performance in the course has been at a satisfactory level.

C Fair

This grade is given to those students whose performance in the course is not at the level expected in graduate work.

F Failure

This grade is given to those students whose performance in the course is unsatisfactory.

In addition, the following letter designations are used:

I Incomplete

This grade is given to those students who fail to complete the work of the course.

S Satisfactory without quality designation.

U Unsatisfactory without quality designation.

These grades are used for the first quarter of a two-quarter sequence in which the grade for the second quarter applies to both the first and second quarters of the sequence. The designations S and U may also be used for thesis and seminar work.

The I grade will be changed to a letter grade upon removal of the deficiency which caused the grade of I to be reported. Deficiencies must be made up within the quarter following that for which the grade of I is received unless an extension of time is granted by the instructor. However, such extension of time may not exceed two additional consecutive calendar quarters.

Any student who wishes to make-up a final examination must obtain permission from the director of the graduate school by the second week of the quarter succeeding that in which the examination was missed. The make-up examination must be taken in that succeeding quarter unless circumstances warrant permission of the director to defer it to one of the next two quarters.

Class Hours and Credits

All credits are entered as quarter hours. A quarter hour of credit is equivalent to three fourths of a semester hour credit. All classes meet on a quarter basis. In the summer session, classes meet for six-week periods. The academic calendar in the front of this catalog should be consulted for the opening and closing dates of each academic quarter.

Continuity of Program

Students are expected to maintain continuous progress toward the degree. Any student who has not attended the Graduate School of Engineering for a period of one year must apply to the director for re-admission.

Withdrawals

In order to withdraw from a course, a student must fill out an official withdrawal form obtained at the Registrar's Office or at the Suburban Campus Office. Withdrawals may be made through the ninth class meeting of the quarter. Students will be withdrawn as of the date on which they fill out the official withdrawal form. Ceasing to attend a class or notifying the instructor does not constitute an official withdrawal.

Requests for withdrawal from a course after the ninth class meeting of the quarter may be submitted to the Director of the Graduate School, and may be approved to avert unusual hardships on a student.

Changes in Requirements

The continuing development of the graduate school forces frequent revision of curricula. In every new bulletin some improvements are indicated. When no hardship is imposed on the student because of changes, and when the facilities of the school permit, the student is expected to meet the requirements of the latest bulletin. If the student finds it impossible to meet these requirements, the bulletin for the year in which he entered becomes the binding one.

Filing for the Degree

Each student who plans to graduate either in June or September must submit to the Registrar's Office a completed commencement data card prior to the deadline listed in the academic calendar for that commencement at which he expects to receive the degree. If the deadline for filing is not met there is no assurance that the degree will be awarded that year. The commencement data card is supplied with the registration materials or is available in the Registrar's Office.

THE MASTER'S DEGREE

Admission

Specific requirements for each degree program will be found in the appropriate paragraphs for each academic department in the Graduate School of Engineering. General Requirements are listed under *Application Procedures*.

Academic Classifications

Students initially entering the Graduate School are classified into one of three groups according to their admission qualifications.

Regular students are those who meet in full all admittance criteria based on the standards established by the Committee on Graduate Study in Engineering.

Provisional students are those whose records are above the minimum required for acceptance but do not qualify them for regular admission based on the standards established. Therefore, provisional students must obtain a B average in their first 12 quarter hours of course work to continue in the graduate school and be reclassified as regular.

Special students are those who do not wish to pursue a master's degree program or who may already possess the master's degree. Special students with only the bachelor's degree must meet the same admission criteria as the regular or provisional student and will be limited to a maximum of 12 quarter hours of graduate credits.

Any student whose record is not satisfactory may be dropped from the program regardless of his classification.

Academic Requirements

A candidate for the master's degree must satisfactorily complete an approved program consisting of a minimum of 40 quarter hours of correlated work of graduate caliber and such other study as may be required by the department in which he is registered.

To qualify for the Master of Science degree from the Graduate School of Engineering each student must have an average grade accumulative of not less than B with no more than 12 credits below a B in all courses undertaken at Northeastern University. The Committee on Graduate Study in Engineering allows eight quarter hours of credit to be taken in addition to the stated degree requirements to repeat failed required courses or to substitute for elective courses to obtain the required B average for completion of degree requirements. The number of I grades that a student may accrue will be limited.

Within the above limitations for extra or repeated courses, a required course for which a grade of F is received must be repeated with a grade of C or better, and may be repeated only once. If a grade of F is

received in an elective course, that course may be repeated once to obtain a grade of C or better, or another elective course may be substituted for it. If a grade of C is received in a required course, that course may be repeated once to obtain a grade of B or better.

Comprehensive Examination

At the discretion of the department, a final written or oral comprehensive examination may be required. Such examinations will be given at least two weeks before the commencement at which the degree is expected.

Thesis

If a thesis is required in partial fulfillment of degree requirements, it must show independent work based in part upon original material, and must meet the approval of the departmental graduate committee.

The thesis must receive a grade of B or better to be accepted. Instructions for the preparation of the thesis may be obtained from the department.

Transfer Credits

A maximum of 12 quarter hours of credit obtained at another institution may be accepted toward the master's degree provided that the credits transferred are in the candidate's field, consist of work taken at the graduate level for graduate credit, carry grades of A or B, have been earned at a recognized college or university, and have not been used toward any other degree. Students should petition the Graduate School of Engineering in writing for all transfer credits. Grades on transfer credits may not be used for the purpose of obtaining the academic average necessary for completion of the degree requirements.

Time Limitations

Course credits earned in the program of graduate study, or accepted by transfer, are valid for a maximum of seven years unless an extension is granted by the graduate school committee.

Fellowships

The departments of the Graduate School of Engineering have two types of fellowships available. Some departments have teaching assistantships and research fellowships for students enrolled in work leading to the master's degree. The departments which give doctoral degrees also have research fellowships for such students.

Assistantships

Some departments have teaching assistantships, on the Cooperative Plan, in which students alternate full-time academic work with full-time

work in the department. Some departments also have available research fellowships. Applications for traineeships must be filed by March 15, with two letters of recommendation and a transcript of all prior college work. All students must have their course program approved by the chairman of the respective department before the student registers.

Cooperative Programs

All the departments offer the Cooperative Education Plan. The Plan consists of nine months of classroom study and twelve months of work experience in an industrial concern.

Full-Time Program

All the departments offer a continuous full-time program in which the requirements for the master's degree can be completed in one academic year.

Part-Time Program

Most of the departments offer part-time programs in which the admission requirements are the same as for full-time programs. However, the program is established in such a way that students may progress according to their abilities and the time available. The curricula of the part-time programs are specified by the departments.

An official transcript of prior college work must be submitted with an application by those who apply by mail, or at the personal interview for those who apply after the deadline for mailing. Mail applications will be accepted up to two weeks prior to the registration period for the quarter in which the applicant plans to enter the Graduate School.

Honorary Societies

Northeastern University has chapters of Tau Beta Pi, Sigma Xi, and Phi Kappa Phi. Graduate students are eligible for consideration for election to these societies in accordance with the admission requirements of each organization.

THE DOCTOR OF PHILOSOPHY DEGREE

The Doctor of Philosophy degree is awarded to candidates who give evidence of high attainment and research ability in their major field. The degree requirements are administered by committees in charge of each degree program. These committees may be departmental graduate committees or the committee of the graduate school, depending upon the nature of the program. It is the responsibility of the chairman of the committee to certify to the Graduate School of Engineering the completion of each requirement for each candidate.

Admission

Each degree program has an established admission procedure for students starting their doctoral work at Northeastern University. Initial contact should be with the chairman of the appropriate department.

Classification and Degree Candidacy

Students taking advanced graduate work are classified as follows:

1. **Doctoral Student**

Students in this classification have been admitted to a doctoral program.

2. **Doctoral Degree Candidate**

Students in this classification are doctoral students who have completed 40 quarter hours of acceptable graduate work beyond the bachelor's degree and have passed the qualifying examination.

3. **Special Students**

This classification is given to students taking advanced graduate work who are not enrolled for a master's degree, and who have not been admitted to a doctoral program.

Residence Requirement

Candidates for the Doctor of Philosophy degree must spend the equivalent of at least one academic year in residence at the University taking graduate work. The committee of each degree program specifies the method by which the residence requirement is satisfied.

Qualifying Examination

Students must pass a qualifying examination within time limits set by the committee of the degree program. The material covered in the qualifying examination and the level of course work necessary to prepare for the examination are established by the committee for each program.

Comprehensive Examination

Degree programs may require a comprehensive examination during the time in which a student is a degree candidate. The purpose of this examination is to test the knowledge and skills of the student in a particular area and his knowledge of recent research developments in his field.

Course Requirements

The minimum course requirements of 40 quarter hours constitute the work normally required for a master's degree. The course require-

ments beyond this are the doctoral course requirements and the amount of such work necessary in each doctoral program is specified by the committee in charge of the doctoral program.

Dissertation

Each doctoral student must complete a dissertation which embodies the results of extended research and makes an original contribution to the field. This work should give evidence of the candidate's ability to carry out independent investigation and interpret in a logical manner the results of the research. The method of approval of the dissertation is established by the committee in charge of the degree program. The original bound copy of the dissertation must be deposited in the library.

Language Requirement

The foreign language requirement and how it is satisfied is established by the committee in charge of each degree program.

Final Oral Examination

The final oral examination will be taken after completion of all other requirements for the degree. This examination must be held at least two weeks before the commencement at which the degree is to be awarded.

The committee for the final oral examination for the doctoral degree is appointed by the committee in charge of the degree program, and the director of the graduate school is notified of the time of the examination.

The final oral examination will be on the subject matter of the doctoral dissertation and significant developments in the field of the dissertation. Other fields may be included if recommended by the examining committee.

Transfer Credit

If transfer credit for doctoral course work is desired, approval for such transfer credit must be given by the committee in charge of the degree program.

Time Limitation

After the establishment of degree candidacy, a maximum of five years will be allowed for the completion of the degree requirements. If a student wishes to obtain a time extension, he may, with the approval of the committee of his degree program, petition the Committee on Doctoral Degree Programs of the University Graduate Council for such extension.

Registration

All students must register for course work or dissertation as approved by their advisers or the departmental registration officer. After the first registration for doctoral work, registration must be continuous unless withdrawal is allowed by the committee in charge of the degree program. Students must be registered for dissertation during the quarter in which they take the final oral examination.

THE DOCTOR OF ENGINEERING DEGREE

The Doctor of Engineering degree is awarded to candidates who give evidence of high attainment and ability in their major field. The degree requirements are administered by committees in charge of each degree program. These committees may be departmental graduate committees or the committee of the graduate school depending upon the nature of the program. It is the responsibility of the chairman of the committee to certify to the Graduate School of Engineering the completion of each requirement for each candidate.

Admission

Each degree program has an established admission procedure for students starting their doctoral work at Northeastern University. Initial contact should be with the chairman of the appropriate department.

Classification and Degree Candidacy

Students taking advanced graduate work are classified as follows:

1. Doctoral Student

Students in this classification have been admitted to the doctoral program.

2. Doctoral Degree Candidate

Students in this classification are doctoral students who have completed 40 quarter hours of acceptable graduate work beyond the bachelor's degree and have passed the qualifying examination.

3. Special Students

This classification is given to students taking advanced graduate work who are not enrolled for a master's degree, and who have not been admitted to a doctoral program.

Residence Requirement

Candidates for the Doctor of Engineering degree must spend the equivalent of at least one academic year in residence at the University

taking graduate work. The committee of each degree program specifies the method by which the residence requirement is satisfied.

Qualifying Examination

Students must pass a qualifying examination within time limits set by the committee of the degree program. The material covered in the qualifying examination and the level of course work necessary to prepare for the examination are established by the committee for each program.

Comprehensive Examination

Degree programs may require a comprehensive examination during the time in which a student is a degree candidate. The purpose of this examination is to test the knowledge and skills of the student in a particular area and his knowledge of recent research developments in this field.

Course Requirements

The minimum course requirements of 40 quarter hours constitute the work normally required for a master's degree. The course requirements beyond this are doctoral course requirements, and the amount of such work necessary in each doctoral program is specified by the committee in charge of the doctoral program.

Dissertation

The dissertation for the Doctor of Engineering degree is fundamentally different from that of the Doctor of Philosophy degree. In general, the latter focuses on contributions to new knowledge in the engineering sciences and is expected to demonstrate the student's competence as a researcher. The dissertation for the Doctor of Engineering degree focuses on creative engineering design and in-depth engineering studies. It may, and usually will, contain elements that involve research, but above all, it must demonstrate the student's ability to work creatively on engineering analysis and design problems such as those encountered in professional practice.

Language Requirement

There is no foreign language requirement, but, in lieu of such a requirement, the student must demonstrate proficiency in computer software techniques and an acceptable machine language.

Final Oral Examination

The final oral examination will be taken after completion of all other requirements for the degree. This examination must be held at least two

weeks before the commencement at which the degree is to be awarded.

The committee for the final oral examination for the doctoral degree is appointed by the committee in charge of the degree program, and the director of the graduate school is notified of the time of the examination.

The final oral examination will be on the subject matter of the doctoral dissertation and significant developments in the field of the dissertation. Other fields may be included if recommended by the examining committee.

Transfer Credit

If transfer credit for doctoral course work is desired, approval for such transfer credit must be given by the committee in charge of the degree program.

Time Limitation

After the establishment of degree candidacy, a maximum of five years will be allowed for the completion of the degree requirements. If a student wishes to obtain a time extension, he may, with the approval of the committee of his degree program, petition the Committee on Doctoral Degree Programs or the University Graduate Council for such extension.

Registration

All students must register for course work or dissertation as approved by their advisers or the departmental registration officer. After the first registration for doctoral work, registration must be continuous unless withdrawal is allowed by the committee in charge of the degree program. Students must be registered for dissertation during the quarter in which they take the final oral examination.

Professional Experience

The student is required to present evidence of at least one calendar year of experience in engineering practice at a suitable professional level. This experience must have been acquired after completion of a bachelor's degree in a branch of engineering. The committee in charge of each degree program specifies the details of the professional experience requirement.

INTERDISCIPLINARY PROGRAMS

Some graduate students may wish to pursue doctoral programs which involve substantial work in two or more departments. To meet this need,

an interdisciplinary program may be established which corresponds in scope and depth to doctoral standards, but does not agree exactly with the individual departmental regulations. For such possibilities, the following plan is in operation:

Admission

Application for admission to interdisciplinary doctoral study consists of the submission of a carefully thought-out written proposal describing the areas of proposed study and research. The proposal may be a part of the initial application for admission to graduate study at Northeastern University, or it may be submitted by a student already enrolled. It may be directed to a doctoral degree-granting department or to the director of the graduate school, who directs it to the appropriate department. In either case, admission to interdisciplinary doctoral study requires favorable recommendation by the sponsoring doctoral degree-granting department and approval by authorized representatives of the graduate study committees of the departments appropriate to the disciplines covered by the applicant's proposal. The sponsoring department becomes the registration base of the student.

Formation of Interdisciplinary Committee

A student who has been accepted for interdisciplinary study must obtain the consent of an adviser who will direct his doctoral thesis. This adviser, who may or may not be a member of the registration department, will be chairman of the interdisciplinary committee for this student. A second member will be appointed from the registration department by its chairman. These two members will obtain one or more additional members or request the director of the graduate school to do so. At least two departments must be represented on the committee and a majority of the committee must come from doctoral degree-granting departments. The chairman of the registration department will notify the director of the graduate school of the membership of the committee as soon as arrangements are complete.

Duties of Interdisciplinary Committee

A member of the interdisciplinary committee who is also a member of the registration department will serve as the registration officer to approve the course registration for the student. A copy of the approved course registration must also be filed with the other committee members and with the graduate study committee of the registration department.

The interdisciplinary committee will be responsible for the administration of the qualifying examination, language examination, approval of the dissertation, and comprehensive examination. This committee must

also certify to the registration department the completion of the requirements for the award of the doctoral degree.

The interdisciplinary committee must assure that the program of the student represents standards comparable to those of the registration department and that the program is not so broad that it has inadequate depth in any area.

The program of the student may be reviewed at any time by the director of the graduate school to determine whether objectives of the program are being met.

THE ENGINEER DEGREE

The degree of Engineer is intended for those who do not wish to make a commitment to post-master's degree graduate study that is as extensive as that required for one of the doctor's degrees. It is an intermediate degree, between master's and doctor's degrees. A student who has completed the Engineer degree is eligible to apply for admission to a doctor's degree program.

Admission

Each departmental Engineer degree program has its own admission procedure for students beginning the program. Normally a master's degree in engineering or related field is required. Initial contact should be with the chairman of the appropriate department.

Classification and Degree Candidacy

A student admitted to the Engineer degree program will be designated as a candidate for this degree.

Residence Requirement

Candidates for the Engineer degree must spend the equivalent of at least two academic quarters in residence at the University taking graduate work. The committee of each degree program specifies the method by which the residence requirement is satisfied.

Qualifying and Comprehensive Examinations

The committee for each Engineer degree program specifies its own examinations. Normally, no qualifying examination is required for candidacy and no comprehensive examination is required for completion, but individual departments offering the degree may require such examinations.

Course Requirements

The minimum course requirement will be 40 quarter hours beyond the master's degree, with no more than 10 quarter hours of credit out of the 40 allowed for work on the dissertation. A minimum of 20 quarter hours must be taken in the department in which the degree is offered. Specific course requirements for each Engineer degree program are determined by the departmental committee in charge of the program.

Dissertation

Each Engineer degree student must complete a dissertation which demonstrates a high level of competence in engineering research, development, or design. As a general guideline, the amount of effort normally expected will be the equivalent of about 10 quarter hours of graduate course work.

Language Requirement

No foreign language is required for the Engineer degree.

Final Oral Examination

A final oral examination may be required by the departmental committee in charge of the Engineer degree program. The examination will normally consist of a defense of the dissertation.

Transfer of Credit

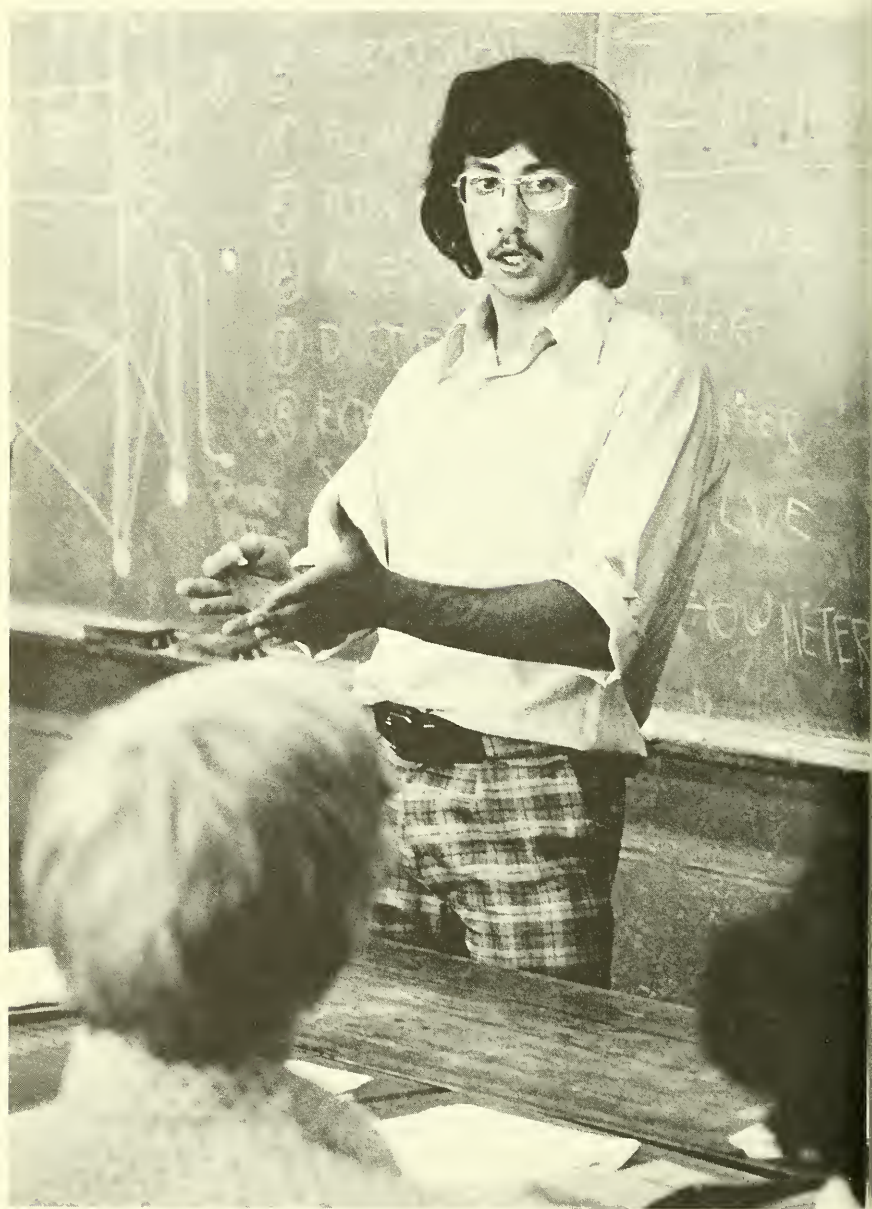
Approval for transfer of credit must be given by the departmental committee in charge of the degree program.

Time Limitation

After admission to the program, a maximum of five years will be allowed for completion of the degree requirements. Extension of this time limit may be granted with the approval of the departmental committee in charge of the degree program.

Registration

All students must register for course work or dissertation as approved by their advisers or the departmental registration officer. After the first registration for this work, registration must be continuous unless withdrawal is allowed by the departmental committee in charge of the degree program.



financial information

FINANCIAL OBLIGATIONS

Tuition

Tuition rates and fees are subject to revision by the Board of Trustees at any time. However, any change in tuition and fees will become effective at the beginning of the school year which follows the one in which the change was announced.

The tuition rate for all graduate students is \$57 per quarter hour of credit. Doctoral candidates actively utilizing the resources of the University in their Doctor of Philosophy or Doctor of Engineering dissertation are charged an additional \$600 per quarter. Those doctoral candidates registered for dissertation work to be performed off campus are charged \$200 per quarter in addition to tuition. All doctoral candidates who are no longer actively utilizing University resources are charged a continuation fee of \$50 per quarter.

Tuition statements are mailed to students by the Bursar's Office and are payable by cash or check to Northeastern University on or before the date specified.

Fees

A \$15.00 non-refundable application fee must accompany the application for admission to the Graduate School of Engineering. No applications will be processed until the fee has been received.

Upon notification of acceptance, all full-time applicants are required to pay a tuition deposit of \$50.00. This deposit will be credited to the student's tuition, and it is not refundable for those who do not register.

Other fees include a charge of \$10 for late payment of tuition and a commencement fee of \$25 for all degree candidates, payable before commencement by the date listed in the academic calendar.

For full-time students there is a charge of \$12.50 per quarter for the services available in the Student Center. The fee for teaching assistants and research fellows is \$6.25 each quarter. All part-time students on the Huntington Avenue Campus are charged \$.75 a quarter.

All full-time students pay a non-refundable University Health Service fee of \$90 each year. This fee will provide Blue Cross-Blue Shield

coverage and entitle the students to the medical care furnished by the University Health Services.

All financial obligations to the University must be discharged by graduation.

Refunds

Tuition refunds will be granted only on the basis of the date appearing on the official withdrawal form filed by the student. Nonattendance does not constitute official withdrawal. Questions regarding refunds should be discussed with the Bursar's Office.

Refunds will be granted in accordance with the following schedule:

Amount of Refund:	
Official Withdrawal Filed Within:	Percentage of Tuition
First week of quarter	100
Second week of quarter	75
Third week of quarter	50
Fourth week of quarter	25

FINANCIAL AID

Northeastern University has available the following types of assistantships and fellowships for support of graduate students. Those interested in financial aid must apply through the chairman of the major department. The chairmen or representatives of the Department are listed in the catalog under the Committee on Graduate Study in Engineering.

Teaching Assistantships

Teaching assistantships allowing remission of tuition and a stipend are available in all departments. Holders of such awards devote half time to academic assistance directly related to the teaching function and the balance to course work.

Graduate Administrative Assistantships

Some University departments offer the graduate student an opportunity for remission of tuition and a stipend in return for half time spent in assisting with non-teaching, administrative duties.

Tuition Assistantships

Many departments provide remission of tuition for students who share in the administrative work of the department. These awards are normally given to full-time students in the first year of graduate work.

Research Fellowships

A number of departments offer research fellowships including N.I.H. and N.S.F. that carry a stipend and remit tuition. Certain of these grants require half-time work on research in the department, with the remaining time devoted to course work. Others provide for full-time work on research used for thesis or dissertation.

Martin Luther King, Jr. Scholarships

Established in 1969 in memory of the late Rev. Martin Luther King, Jr., awards are made as openings occur to qualified minority graduate students who show financial need and are accepted to full-time study in the Graduate Schools of the University. Stipends will cover tuition and all fees.

Doctoral Research Fellowships

In the departments which give work leading to the Ph.D. degree, research fellowships available for students who have established candidacy for the Ph.D. degree carry a higher stipend than fellowships at the master's level.

Appointments

Appointments to fellowships and assistantships are ordinarily announced no later than April 15 for the following academic year or summer. Appointments are for a maximum of one year and are not automatically renewed. Students who hold assistantships and research fellowships are expected to devote full time to their studies and the duties of the grant. They may not accept outside employment without the consent of their faculty advisers and the director of the graduate school.

Dormitory Proctorships

A number of proctorships in dormitories on or near the Huntington Avenue campus are available each year. Appointments carry a minimum compensation of room and board. Further information and application forms may be obtained from the Office of University Housing.

National Defense Student Loans

This program is available to students who are carrying at least one-half the normal academic load, are accepted as degree candidates, and who show evidence of financial need.

The Federal maximum a graduate student may borrow is \$5000 while pursuing his post-baccalaureate degree.

Repayment and interest on these loans do not begin until nine months after the student ceases to carry at least a half-time academic load at

an institution of higher education. The repayment of principal may be extended over a ten-year period with the interest at the rate of 3% per annum. Repayment may be deferred up to a total of three years while a borrower is serving as a Peace Corps or VISTA volunteer.

Additional information and application forms are available from the Office of Financial Aid. The application deadline is September 1 for full-time students. For other students the deadline is six weeks prior to the start of the quarter for which aid is requested.

Guaranteed Loan Program

Under this program, students who are matriculated degree candidates, enrolled for at least one-half the normal academic work load, may borrow from a participating bank or other financial institution. Terms and conditions vary from state to state, but a student generally may borrow up to \$1,500 a year (the law allows a maximum of \$2,500 per year) depending on financial need. The Federal government pays the interest while the student is in school if the student is eligible for interest subsidy.

The student must have submitted through the College Scholarship Service, a Parents' Confidential Statement or, if he has been declared financially independent by the Financial Aid Office, a Students' Confidential Statement. These forms are available in the Financial Aid Office.

Applications for the loan itself are available from local banks or the Education Office of your State government. Additional information and necessary application forms for Massachusetts residents are available from the Financial Aid Office.

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civil engineering

Admission

To be enrolled for graduate work leading to the degree of Master of Science in Civil Engineering, applicants must have obtained a Bachelor of Science degree in Civil Engineering, with an acceptable quality of undergraduate work, from a recognized institution. Applicants with a Bachelor of Science degree from a recognized institution in some other engineering field or related science and an appropriate background of preparation may pursue this program and qualify for the degree of Master of Science.

THE MASTER'S DEGREE

General

The master's degree requirements can be completed on the Cooperative Plan, on a full-time basis or part-time in the evening. Forty quarter hours of academic work are required. A master's report carrying 4 Q.H. of credit, or a thesis of 8 Q.H. credit is required* in all fields of civil engineering (environmental, structural and transportation).

A meaningful sequence of electives must be chosen which meets the approval of the department. Department interviews are necessary early in the program for all students in order that an approved program of electives may be arranged with the individual. It is suggested that only required courses be taken in the first quarter. During that quarter an interview should be scheduled within the department for preliminary planning of the remainder of the individual program.

Full-Time Program on the Cooperative Plan

On the Cooperative Plan students enroll for academic work in the Fall and Spring Quarters of the first year and in the Winter Quarter of the second year. The other three quarters of the two academic years and the summer after the first year are available for professional employment. Students who are admitted to a master's degree program under the Cooperative Plan must complete, through satisfactory performance, each cooperative work assignment in order to be eligible for their degree.

* NOTE: This is a new requirement for structural majors and applies to students entering this program in the Fall of 1972.

Full-Time Program

Arrangements may be made to complete the degree requirements in one year on a continuous full-time basis.

Part-Time Programs

The admission requirements for these programs are the same as for the full-time program, but students may progress according to their ability to combine their study load with their employment load. A maximum of seven years is allowed to complete the program.

Substitutions

With the approval of the department, substitutions may be made for some of the prescribed courses by other courses in the department or in other departments which offer graduate work.

Students may petition to substitute eight quarter hours of approved course work for the required four quarter hours Master's Report.

STRUCTURAL ENGINEERING

The Structural Engineering Program emphasizes basic courses in Structural Analysis, Design of Steel and Concrete Structures, and Soil and Rock Mechanics. Advanced topics in Dynamics, Stability, Models and Numerical Methods round out a comprehensive presentation which may be supplemented by offerings from other programs, such as mechanical engineering or industrial engineering.

SPECIMEN DAY PROGRAM

First Academic Quarter	Credits	Second Academic Quarter	Credits
1.847 Structural Analysis . . .	4	1.856 Structural Analysis . . .	4
1.858 Concrete Structures . .	4	1.861 Design of Structures I	2
1.877 Eng. Props. of Soils . .	4	1.878 Foundation Eng.	4
1.882 Engineering Geology .	2	1.894 Numerical Methods	
(Minimum)	14	in Struct. Mechanics .	4
		1.897 Master's Report	4
		or	
		1.899 Thesis	8
		(Minimum)	14
Third Academic Quarter	Credits		
1.855 Concrete Structures III	2		
1.857 Structural Dynamics . .	4		
1.864 Design of Structures .	4		
1.873 Soils Testing Lab. . . .	2		
1.897 Master's Report	4		
or			
1.899 Thesis	8		
(Minimum)	12		

PART-TIME PROGRAM

Required Courses		Credits
1.897	Master's Report	4
	or	
1.899	Thesis	8
	(Minimum)	4

Electives (Part-time Program)

Students in the Structural Engineering major must elect 30 quarter hours from civil engineering courses within the structural engineering field (courses in the 840–899 series).

Six quarter hours may be elected from any courses in engineering or science for which the student has the necessary preparation.

The electives will normally be available according to the following schedule:

Fall Quarter		Credits	Winter Quarter		Credits
1.841	Structural Analysis I . .	2	1.842	Structural Analysis II .	2
1.844	Structural Analysis IV	2	1.850	Struc. Dynamics I	2
1.853	Concrete Structures I .	2	1.854	Concrete Structures II	2
1.859	Structural Stability . . .	2	1.862	Design of Structures II	2
1.861	Design of Structures I	2	1.872	Eng. Props. of Soils II	2
1.871	Eng. Props. of Soils I .	2	1.875	Soil Mechanics and	
1.874	Soil Mechanics and			Foundation Eng. II . . .	2
	Foundation Eng. I	2	1.884	Rock Mechanics I	2
1.882	Eng. Geology I	2	1.892	Numerical Methods in	
				Struct. Mechanics I . .	2
Spring Quarter		Credits			
1.843	Structural Analysis III .	2			
1.849	Model Analysis	2			
1.851	Struct. Dynamics II . . .	2			
1.855	Concrete Structures III	2			
1.863	Design of Structures III	2			
1.873	Soils Testing Lab. . . .	2			
1.876	Soil Mechanics and				
	Foundation Eng. III . .	2			
1.885	Rock Mechanics II . . .	2			
1.893	Numerical Methods in				
	Struct. Mechanics II . .	2			

TRANSPORTATION ENGINEERING

The Transportation Engineering Program is designed for students with career goals in transportation engineering, planning, or research. This program consists of courses from engineering, liberal arts, and business. A minimum of 40 credit hours is required for a graduate degree.

A Master of Science in Civil Engineering degree will be awarded to students who have an accredited undergraduate degree in civil engineering and have completed at least 24 quarter credit hours in civil engineering courses, i.e. courses designated with 01--- numbers. A Master of Science degree will be awarded to students who do not have an undergraduate degree in civil engineering or who do not meet the minimum 24 quarter credit hour requirement in civil engineering courses. A student may elect to take non-technical electives in liberal arts and business administration. A maximum of nine credit hours in non-technical fields will be allowed.

Each student is required to prepare a program of study which must be reviewed and approved by his faculty adviser. A typical program of study would normally consist of courses shown in the specimen program. Specimen programs listed below for day and part-time students is intended to show the nature of the program. Substitutions for the courses listed in the specimen programs may be made depending on the student's interest, academic background, and career objectives.

For a complete listing of courses and course descriptions, consult appropriate sections of the graduate school catalogues for Engineering, Liberal Arts, and Business Administration. Further information can be obtained from the Northeastern University catalogue entitled *Graduate Program in Transportation*. This catalogue describes the interdisciplinary program in transportation which leads to a Master of Science in Transportation degree.

SPECIMEN DAY PROGRAM

Required Courses	Credits	Required Courses	Credits
1.834 Transp. Analysis & Planning	4	1.837 Interdisciplinary Urban Transp. Seminar	2
1.800 Systems Analysis	4	1.839 Thesis (Transp.)	6
1.805 Traffic Flow Theory ..	4		

Suggested Technical Electives

Courses	Credits	Courses	Credits
1.206 Applied Probability for Civil Engineers . . .	4	5.950 Engineering Statistics I	2
1.820 Transp. Engineering .	2	5.951 Engineering Statistics II	2
1.806 Urban Transp. Analysis	4	5.913 Data Processing for Engineers	2
1.819 Environmental Impacts of Urban Transp.	4	5.914 Advanced Opera- tions Research	4

Suggested Non-Technical Electives

Courses	Credits	Courses	Credits
22.847 Politics of Transportation	3	39.9P3 Regional Development	3
39.9L5 Economics of Urban Transp.	3	39.9R1 Development Planning	3
39.9J8 Physical Aspects of Urban-Regional Development	3	48.805 Urban Transp. Management	3

PART-TIME PROGRAM

Part-time students are subjected to the same requirements as full-time students. Courses listed above may be taken by part-time students. Some of these courses are not available in the evening, but appropriate substitutions may be made. The following is a list of required courses:

SPECIMEN PART-TIME PROGRAM

Required Courses	Credits	Required Courses	Credits
1.834 Transp. Analysis & Planning	4	1.838 Master's Report (Transportation)	4
1.810 Systems Analysis I . .	2	or	
1.812 Systems Analysis II . .	2	1.839 Thesis (Transp.)	6
1.803 Traffic Flow Theory I . .	2	1.837 Interdisciplinary Urban Transp. Seminar	2
1.804 Traffic Flow Theory II . .	2		

See Specimen Day Program for suggested Technical and Non-Technical Electives.

ENVIRONMENTAL ENGINEERING

Includes areas of specialization such as water quality management, water and wastewater engineering, environmental health, air pollution control and solid waste management. A day program on the Cooperative Plan is available.

Part-time students and full-time students not on traineeships or grants-in-aid have the option of undertaking either a Master's Report for 4 Q.H. credit or a Master's Thesis for 8 Q.H. credit. (Students on traineeships or with grants-in-aid may be required to complete a Master's Thesis.)

Suggested programs for both full-time and part-time students are given below. Other programs, tailored to meet individual requirements, may be developed through conferences with the student's adviser.

SPECIMEN DAY PROGRAM

First Academic Quarter		Credits	Second Academic Quarter		Credits
1.914	Water & Wastewater		1.922	Env. Bacteriology ...	2
	Treatment	4	1.994	Seminar	2
*1.923	Environmental Chem.	4		Electives	10
1.933	Environmental Anal.	4			<u>14</u>
	Elective	<u>2</u>			
		14			

Third Academic Quarter		Credits
1.912	Water & Wastewater	
	Treatment III	2
	Electives	6 or 2
1.993	Master's Report	4
	or	
1.991	Thesis	<u>8</u>
	(Minimum)	12

PART-TIME PROGRAM

Required Courses		Credits
1.910	Water & Wastewater	
	Treatment I	2
1.911	Water & Wastewater	
	Treatment II	2
1.912	Water & Wastewater	
	Treatment III	2
*1.920	Env. Chemistry I ...	2
*1.921	Env. Chemistry II ...	2
1.922	Env. Bacteriology ...	2
1.930	Env. Analysis I	2
1.931	Env. Analysis II	2
1.993	Master's Report	4
	or	
1.991	Thesis	<u>8</u>
		20 or 24

Elective Groupings (Day and Part-Time)

Forty (40) quarter hours of academic work are required for the degree, including certain approved electives which are available from other departments. To provide a meaningful grouping of the available technical electives, one of the following sequences of courses must be selected. These are the required courses for each area of specialization. A minimum of 14 quarter hours of elective courses must be ob-

* These required courses may be waived for those students who have taken North-eastern course 1.223, Environmental Chemistry, or equivalent. Course 1.933 or courses 1.930 and 1.931 will be required of all students.

tained from environmental engineering courses offered by the Civil Engineering Department (900 series). Exceptions to these requirements must receive permission from the Engineering Graduate Committee.

Water and Wastewater Engineering	Credits
1.935, 1.936 Environmental Lab (U.O.)	4
1.907 W.R. Planning III . . .	2
1.954 Stream Sanitation . .	2
1.913 Ind. Waste Disposal . .	2
1.994 Environmental Eng. Seminar (Trainees Only)	2
Additional Electives	4 or 8

Environmental Health Engineering & Science	Credits
1.985 Environmental Protection	2
or	
1.940 Public Health Survey	2
1.950 Air Pollution	2
1.951 Rad. Health	2
1.952 Ind. Hygiene	2
1.996 Env. Health Seminar (Trainees Only)	2
1.955 Air Sampling Analysis	2
Additional Electives	4 or 8

Water Resources Planning	Credits
1.905, 1.906, 1.907, W.R. Planning	6
1.906, 1.961, 1.962, Hydr. Structure	6
1.901, 1.902, 1.903 Hydraulics	6
Additional Electives	2

Air Pollution Engineering	Credits
1.800 C.E. Systems	4
1.950 Air Pollution	2
1.956 Env. Health Seminar	2
1.955 Air Sampling & Analysis	2
1.957 Air Science	2
Additional Electives	4 or 8

Civil Engineering (Geotechnical)

At the master's degree level it is possible to undertake concentrated study in geotechnical engineering which is concerned with materials within the earth's crust. Students with this interest should consider the following courses recommended by the Civil Engineering Department to obtain a competent knowledge in the field.

Courses	Credits
1.871 Eng. Prop. of Soils I . .	2
1.872 Eng. Prop. of Soils II . .	2
1.873 Soils Testing Lab. . . .	2
1.874 Soil Mechanics and Foundation Eng. I	2
1.875 Soil Mechanics and Foundation Eng. II	2
1.876 Soil Mechanics and Foundation Eng. III . . .	2
1.882 Engineering Geol. . . .	2
1.884 Rock Mechanics I	2
1.885 Rock Mechanics II . . .	2

THE DOCTOR'S DEGREE

Environmental Engineering Full-Time Program

The following material outlines the procedures for admission to the doctoral program in environmental engineering and the steps necessary to qualify for the Ph.D. degree. For further information applicants should write to the Chairman of the Ph.D. Committee, Department of Civil Engineering.

Admission

Each student admitted to the program will initially have the status of doctoral student. In the usual case, he will have received a master's degree in an appropriate field of engineering or science prior to entry into the program. Applicants should apply to the Chairman of the Ph.D. Committee, Department of Civil Engineering for admission to the doctoral program, preferably by February 1st. The departmental graduate committee will interview the applicant, examine his record, and decide whether he should be admitted to the program. The chairman of the department will appoint a program adviser for each doctoral student, upon the recommendation of the departmental graduate committee.

Residence Requirement

The residence requirement is satisfied by one year of full-time graduate work after admission as a doctoral student. However, it is expected that at least two years of full-time graduate study will be required beyond the master's degree.

Degree Candidacy

Degree candidacy is established in accordance with the general graduate school regulations. At least one year of full-time study and successful completion of the qualifying examination are required for consideration as a doctoral degree candidate.

Qualifying Examination

The qualifying examination will consist of a written and an oral section. The written part will cover: (1) environmental engineering and/or science and (2) selected areas depending upon the educational background and interest of the student. In certain cases the student may be exempted from the written part of the examination. The oral portion will measure general comprehension. If the oral examination is failed, it may be repeated with permission of the departmental graduate committee. The qualifying examination shall be completed no later than two years after admittance as a doctoral student.

Comprehensive Examination

The comprehensive examination is given after the thesis has been completed. This examination is based upon the defense of the thesis.

Course Requirements

Course requirements for each applicant will be determined by the departmental graduate committee. Formal course work will be selected to meet the individual student's objectives. Graduate level study up to 12 quarter hours of course work, completed under programs other than this full-time program may be accepted, but requires approval of the departmental graduate committee.

Thesis

After degree candidacy has been established, a candidate must complete a thesis which embodies the results of extended research and includes material suitable for publication.

A thesis committee will be appointed by the chairman of the departmental graduate committee. The thesis committee, consisting ordinarily of five members, two of whom are from other departments, will be informed of the progress of the thesis and will be responsible for its approval.

Language Requirement

A reading knowledge of one foreign language is required. The requirement shall be determined in a manner prescribed by the departmental graduate committee, and must be satisfied prior to taking the oral qualifying examination.

mechanical engineering

Admission

To be enrolled for graduate work leading to the degree of Master of Science in Mechanical Engineering, applicants must have obtained a Bachelor of Science degree in Mechanical Engineering, with an acceptable quality of undergraduate work, from a recognized college or university. Applicants with a Bachelor of Science degree in other engineering or related science fields and an appropriate background of preparation may pursue this program and qualify for the degree of Master of Science without specification.

THE MASTER'S DEGREE

REQUIRED COURSES

Mechanics Major	Credits	Materials Major	Credits
2.826 Math. Methods for Mech. Eng. I	2	2.826 Math. Methods for Mech. Eng. I	2
2.827 Math. Methods for Mech. Eng. II	2	2.827 Math. Methods for Mech. Eng. II	2
2.804 Theory of Elasticity .. and	2	2.954 Adv. Physical Met. I ..	2
2.805 Theory of Elasticity .. or	2	2.956 Adv. Physical Met. II .	2
2.819 Fluid Dynamics I and	2	2.970 Mat. Sci. and Eng. ...	2
2.820 Fluid Dynamics II	2	2.971 Mat. Sci. and Eng. ...	2
2.841 Vibration Theory and	2	2.804 Theory of Elasticity ..	2
2.842 Vibration Theory or	2	or	
2.849 Automatic Cont. Eng. 2		2.960 Thermo. of Materials .	2
and		and	
2.850 Automatic Cont. Eng. 2		2.961 Thermo. of Materials .	2
and			
2.851 Automatic Cont. Eng. 2			
	<hr/> 12 or 14		<hr/> 14 or 16

Thermo-Fluids Major	Credits	Ocean Engineering Major	Credits
2.826 Math. Methods for Mech. Eng. I	2	(open to continuous full-time and cooperative plan students only)	
2.827 Math Methods for Mech. Eng. II	2	2.826 Math. Methods for Mech. Eng. I	2
2.819 Fluid Dynamics I	2	2.827 Math. Methods for Mech. Eng. II	2
2.820 Fluid Dynamics II	2	2.819 Fluid Dynamics I	2
2.901 Adv. Thermodynamics	2	2.820 Fluid Dynamics II	2
2.902 Adv. Thermodynamics	2	2.870 Ocean Engineering I .	2
2.910 Conduction Heat Trans.	2	2.871 Ocean Engineering II .	2
2.911 Convection Heat Trans.	2	2.873 Geophysical Eng. . . .	2
	<u>16</u>	2.874 Ocean Measurements	<u>2</u>
			<u>16</u>

In addition, 2.990 Seminar and 2.991 Thesis are required for continuous full-time and cooperative plan students in all majors.

Electives

Students must take sufficient mechanical engineering departmental electives so that the required courses in their major and the departmental electives total at least 30 of the 40 quarter hours required for the degree.

The remaining ten credits may be elected from any courses in engineering or science for which the student has the necessary preparation.

Full-Time Program on the Cooperative Plan

Forty quarter hours of academic work are required. This program may be taken on the Cooperative Plan where students enroll for academic work in the Fall and Winter Quarters of the first year and in the Fall and Winter Quarters of the second year. The other quarters of the two academic years and the summer after the first year are available for professional employment. Students who are admitted to a master's degree program under the Cooperative Plan must complete, through satisfactory performance, each cooperative work assignment in order to be eligible for their degree.

A thesis of ten quarter hours of credit is required unless waived by the department graduate committee.

Majors in mechanics, materials, thermo-fluids, and ocean engineering are available. The sequence of courses on the Cooperative Plan will normally be taken according to the following pattern:

MECHANICS MAJOR

First Academic Quarter	Credits	Second Academic Quarter	Credits
2.826 Math. Methods for Mech. Eng. I	2	2.827 Math. Methods for Mech. Eng. II	2
2.804 Theory of Elast.	2	2.805 Theory of Elast.	2
or		or	
2.819 Fluid Dynamics I	2	2.820 Fluid Dynamics II	2
2.841 Vibration Theory	2	2.842 Vibration Theory	2
or		or	
2.849 Automatic Cont. Eng. . .	2	2.850 Automatic Cont. Eng. . .	2
Electives	4	Electives	4
	<u>10</u>		<u>10</u>

Third Academic Quarter	Credits	Fourth Academic Quarter	Credits
2.990 Seminar	1	2.990 Seminar	1
2.991 Thesis	5	2.991 Thesis	5
Electives	4	Electives	4
	<u>10</u>		<u>10</u>

MATERIALS MAJOR

First Academic Quarter	Credits	Second Academic Quarter	Credits
2.804 Theory of Elasticity . .	2	Elective	2
or		or	
2.960 Thermodynamics of Materials	2	2.961 Thermodynamics of Materials	2
2.970 Material Science & Engineering	2	2.971 Material Science & Engineering	2
or		or	
2.954 Advanced Physical Metallurgy I	2	2.956 Advanced Physical Metallurgy II	2
2.826 Math. Methods for Mech. Eng. I	2	2.827 Math. Methods for Mech. Eng. II	2
Electives	4	Electives	4
	<u>10</u>		<u>10</u>

Third Academic Quarter	Credits	Fourth Academic Quarter	Credits
2.954 Advanced Physical Metallurgy I		2.956 Advanced Physical Metallurgy II	
or		or	
2.970 Material Science & Engineering	2	2.971 Material Science & Engineering	2
2.990 Seminar	1	2.990 Seminar	1
2.991 Thesis	5	2.991 Thesis	5
Elective	2	Elective	2
	<u>10</u>		<u>10</u>

THERMO-FLUIDS MAJOR

First Academic Quarter		Credits	Second Academic Quarter		Credits
2.819	Fluid Dynamics I	2	2.820	Fluid Dynamics II	2
2.826	Math. Methods for Mech. Eng. I	2	2.827	Math. Methods for Mech. Eng. II	2
2.901	Advanced Thermodynamics	2	2.902	Advanced Thermodynamics	2
2.910	Conduction Heat Transfer	2	2.911	Convection Heat Transfer	2
	Elective	2		Elective	2
		<u>10</u>			<u>10</u>
Third Academic Quarter		Credits	Fourth Academic Quarter		Credits
2.990	Seminar	1	2.990	Seminar	1
2.991	Thesis	5	2.991	Thesis	5
	Electives	4		Electives	4
		<u>10</u>			<u>10</u>

OCEAN ENGINEERING MAJOR

First Academic Quarter		Credits	Second Academic Quarter		Credits
2.819	Fluid Dynamics I	2	2.820	Fluid Dynamics II	2
2.826	Math. Methods for Mech. Eng. I	2	2.827	Math. Methods for Mech. Eng. II	2
2.870	Ocean Engineering I	2	2.871	Ocean Engineering II	2
2.873	Geophysical Engineering	2	2.874	Ocean Measurements	2
	Elective	2		Elective	2
		<u>10</u>			<u>10</u>
Third Academic Quarter		Credits	Fourth Academic Quarter		Credits
2.990	Seminar	1	2.990	Seminar	1
2.991	Thesis	5	2.991	Thesis	5
	Electives and/or Marine Biology	4		Electives	4
		<u>10</u>			<u>10</u>

Continuous Full-Time Program

Students may take the 40 quarter hours of academic work on a continuous full-time basis and complete the degree requirements in one academic year. The sequence of courses which students take on this plan is established by their adviser.

Electives

With the approval of the adviser, a maximum of ten quarter hours of credit may be elected from graduate courses in other departments.

Part-Time Programs

The admission requirements for these programs are the same as for the full-time program, but students may progress according to their abilities and the time available. All majors except ocean engineering are offered on a part-time basis in the evening.

Advisers For Part-Time Programs

The following faculty should be contacted by part-time graduate students if information is required relative to any scholastic problems.

Materials major	Prof. Richard Murphy
Mechanics major	Prof. John Rossettos
Thermo-Fluids major	Prof. Warren Nelson
Ocean Engineering major	Prof. Thomas Phalen

THE MECHANICAL ENGINEER DEGREE

The Department of Mechanical Engineering offers the graduate degree of Mechanical Engineer for those who wish to undertake graduate study beyond the master's degree without committing themselves to a program as extensive as that required for the doctor's degree. The degree permits a candidate to pursue a course of study at the upper graduate level in more than one area of mechanical engineering.

The following material outlines the procedures for admission to the Mechanical Engineer degree program and the steps necessary to qualify for the degree. For further information applicants should write to the Mechanical Engineering Graduate Committee, Room 75, Richards Hall, Northeastern University, Boston, Ma. 02115.

Admission

To be admitted to candidacy for the degree of Mechanical Engineer, the applicant will have obtained the degree of Master of Science in Mechanical Engineering, or its equivalent, from a recognized institution. In some cases, where the Master's degree is not in Mechanical Engineering, the applicant may be admitted to the program on a conditional basis with the stipulation that certain deficiencies be removed without credit toward the degree. Such special admission is dependent upon the approval of the Mechanical Engineering Graduate Committee.

Each applicant must submit to the Graduate Committee, prior to April 1, transcripts of his undergraduate and graduate records and three letters of recommendation which indicate his ability to carry out advanced graduate work.

In general, it is assumed that the applicant will choose two areas of emphasis in his graduate program of study. An outline of his program must be submitted to the Graduate Committee for approval. It is recommended that the applicant discuss his program with the Graduate Committee and members of the graduate faculty in his areas of emphasis prior to submission of his program for approval.

Classification and Degree Candidacy

A student admitted to the Engineer degree program will be designated as a candidate for this degree.

Residence Requirement

The residence requirement is satisfied by two academic quarters of full-time graduate work during the academic year or by four academic quarters of half-time graduate work during two consecutive academic years. Plans for satisfying the residence requirement on a half-time basis must be approved in advance by the Graduate Committee.

Qualification and Examinations

A student must maintain a "B" average to qualify for the degree. Students admitted on a conditional basis may be required to pass special examinations. The Graduate Committee will determine the need for and will administer any such special examinations. A final oral examination consisting of a defense of the dissertation may be required if the candidate's adviser and the Departmental Graduate Committee so decides.

Credit Requirements

A minimum of 40 quarter-hours of credit beyond the master's degree is required. Up to 10 quarter-hours of credit will be permitted for work on a dissertation. A minimum of 20 quarter-hours of credit must be in the Mechanical Engineering Department.

Dissertation

To be awarded the Mechanical Engineer degree each candidate must complete a separate dissertation demonstrating a high level of competence in research, development, or design in the field of Mechanical Engineering. The effort normally expected will be the equivalent of 10 quarter-hours of graduate course work.

Transfer Credits

Any transfer of credits must be approved by the Graduate Committee.

Time Limitation

After admission to the program a maximum of five years will be permitted for completion.

Registration

All students must register with the Departmental Registration Officer for course work or dissertation approved by the Graduate Committee or the student's adviser. After the first registration for this work, registration must be continuous unless withdrawal is allowed by the Graduate Committee.

THE DOCTOR'S DEGREE

The following material outlines the procedure for admission to the doctoral program and the steps necessary to qualify for the Ph.D. degree. For further information, applicants should write to the Chairman of the Department of Mechanical Engineering.

Admission

Applicants who are enrolled as candidates for the degree of Master of Science in Mechanical Engineering at Northeastern University should apply in writing to the Chairman of the Department of Mechanical Engineering for admission to the doctoral program. Such application must be made by February 1st of the year in which they expect to receive the master's degree. The departmental graduate committee will examine the record of the applicant and decide whether or not he should be allowed to take the qualifying examination.

Applicants who are enrolled for graduate work at other institutions or who have completed the requirements for the master's degree should write the chairman of the department for an application for an interview. This form, transcripts of all undergraduate and graduate work, together with three letters of recommendation must be transmitted to the chairman of the departmental graduate committee. The applicant will be notified of an interview time and, after the interview, will be advised if he will be invited to take the qualifying examination and if he should make formal application for admission to the doctoral program. The application for interview, transcripts, and letters of recommendation must be received by February 1st if the March qualifying examination is to be taken.

Residence Requirement

The residence requirement is satisfied by one year of full-time graduate work or by two years of half-time graduate work beyond the master's degree. However, a student should expect to spend at least two years, or the equivalent, in full-time graduate study beyond the requirements of the master's degree.

Degree Candidacy

After 40 quarter hours of graduate work have been taken with satisfactory grades and upon successful completion of the qualifying examination, a student is established as a degree candidate.

Qualifying Examination

The qualifying examination in the Department of Mechanical Engineering is offered yearly in March and/or April and is both written and oral. The written portion of the qualifying examination is six hours in length and covers, with equal emphasis, four different areas. A student

must select one area from each of the three groups A, B, and C plus another area either listed below or unlisted, but considered equivalent and approved by the graduate committee.

A.

Concepts of Thermodynamics
Applied Thermodynamics

B.

Dynamics
Mechanics of Deformable Bodies

C.

Heat and Mass Transfer
Fluid Mechanics
Mechanical Behavior of Materials
Physical Metallurgy

The oral portion of the qualifying examination is conducted by a committee consisting of at least four members appointed by the graduate committee. A typical committee is composed of two members specializing in the student's major area plus one member from each of two other areas.

The qualifying examination may be taken by a graduate student who expects to complete the requirements for his master's degree within three months of the date of the qualifying examination as well as by a person who has already completed the requirements for the master's degree. Because degree candidacy must be established before the graduate committee will act to approve course programs or thesis proposals, the qualifying examination should be taken at the earliest opportunity. If the examination is failed, it may be repeated with permission of the departmental graduate committee.

Course Requirements

To receive the Ph.D. degree a candidate must complete a program of course work approved by the graduate committee. Courses completed prior to admittance to the doctoral program are subject to the approval of the graduate committee. Each program must contain at least twelve quarter hours of course work, preferably outside of the department, in an area other than that in which the candidate is majoring. Attainment of a B average for the courses in the "minor" portion of the program will signify satisfactory completion of that portion.

Thesis

After degree candidacy has been established, a candidate must complete a thesis which embodies the results of extended research and includes materials suitable for publication.

The departmental graduate committee may require the completion of certain course work before permitting thesis work to commence. A thesis committee will be appointed by the chairman of the department upon the recommendation of the departmental graduate committee.

The thesis committee will be kept informed of the progress of the thesis and will be responsible for initial approval of the thesis in its final form.

Language Requirement

A reading knowledge of one foreign language is required. Proficiency in a language shall be determined in a manner prescribed by the departmental graduate committee. The language requirement must be satisfied no later than six months before the time at which the degree is to be conferred.

Comprehensive Examination

The comprehensive examination is combined with the final oral examination and is given after the thesis has been completed and approved. This examination is based upon the subject matter of the thesis and a defense of it.

Final Oral Examination

The final oral examination is taken after completion of all other requirements for the degree. This examination cannot be held until two weeks have elapsed after the thesis has been registered and accepted by the graduate school and must be passed at least two weeks before the commencement at which the degree is to be awarded.

The final oral examination will include the subject matter of the doctoral thesis and significant developments in the field of the thesis work. Other fields may be included if recommended by the examining committee.

electrical engineering

Admission

To be enrolled for graduate work leading to the degree of Master of Science in Electrical Engineering, applicants must have obtained a Bachelor of Science degree in Electrical Engineering, with an acceptable quality of undergraduate work, from a recognized college or university. Applicants with a Bachelor of Science degree in other engineering or related science fields and an appropriate background of preparation may pursue this program and qualify for the degree of Master of Science without specification. In some cases, students whose Bachelor of Science degree is in some other engineering or related science field may qualify for the degree of Master of Science in Electrical Engineering. This requires special approval of the Department of Electrical Engineering.

THE MASTER'S DEGREE

Full-Time Program on the Cooperative Plan

Forty quarter hours of academic work are required. This program may be taken on the Cooperative Plan. On this plan one group of students takes academic work in the Fall and Spring Quarters of the first year and in the Winter Quarter of the second year. Another group may take the academic work in the Winter Quarter of the first year and in the Fall and Spring Quarters of the second year. In either case, the other three quarters of the two academic years and the summer after the first year are available for professional employment. Students who are admitted to a master's degree program under the Cooperative Plan must complete, through satisfactory performance, each cooperative work assignment in order to be eligible for their degree.

The sequence of courses on the Cooperative Plan will normally be taken according to the following pattern:

First Academic Quarter	Credits	Second Academic Quarter	Credits
3.827 Linear Systems Analysis	4	3.832 Network Synthesis I	4
3.842 Linear Active Circuits	4	3.990 Seminar I	2
3.823 Mathematical Methods in Electrical Engineering	4	3.902 Appl. Prob. & Stoch. Proc.	4
Electives	2 or 4	Electives	4 or 6
	<hr/> 14 or 16		<hr/> 14 or 16

Third Academic Quarter		Credits
3.877	Electromagnetic Theory	4
3.991	Seminar II	2
	Electives	8 or 10
		<hr/> 14 or 16

A limited amount of work may be elected from the part-time program.

A thesis for six quarter hours credit is elective with the approval of the chairman of the department. If the thesis option is approved, this work is done in the second year of the program. Details concerning thesis proposals, editorial format, and time schedules are available in the Graduate School Office.

The program of each student will be made up from the required and elective courses available in each term and approved by the student's academic adviser.

Electives

The electives will normally be available according to the following schedule:

Fall Quarter

- 3.902 Applied Probability and Stochastic Processes
- 3.959 Control Theory I — Analysis and Synthesis
- 3.979 Electronic Digital Computers

Winter Quarter

- 3.902 Applied Probability and Stochastic Processes
- 3.909 Detection and Estimation Theory
- 3.962 Control Theory II — Nonlinear and Sampled-Data Systems
- 3.979 Electronic Digital Computers

Spring Quarter

- 3.8T9 Digital Filtering
- 3.902 Applied Probability and Stochastic Processes
- 3.905 Information Theory and Coding
- 3.954 Systems Analysis
- 3.965 Control Theory III — Optimal Control and Stochastic Systems

(Additional electives will be available from the late afternoon portion of the part-time program in all quarters.)

Full-Time Program

For those students whose programs would be better served by full-time study the prescribed courses may be taken in one academic year. The sequence of the required courses will be different from the full-time program on the Cooperative Plan.

POWER SYSTEMS MAJOR

Full-Time Program on the Cooperative Plan

Three organizational modes are offered in our Power Systems Engineering Program which lead to an M.S. in Electrical Engineering.

One may take the course work on the Northeastern Cooperative Plan combining alternate periods of study with work periods in power related areas; one may study full time, or one may take the curriculum on a part-time basis in the evening. The length of time required varies a bit with the student's background, but generally can be computed on the basis of a minimum of 40 quarter hours of course work.

For students enrolled in Northeastern's Power Systems Program at the undergraduate level, it is possible (and customary) to take 8 q.h. of credit toward the M.S. over the last two undergraduate years. These courses usually comprise 3.902 Probability and 2.237 Nuclear Engineering II, but other options (e.g. 3.959 Control Systems I, 3.295 Numerical Methods and Computer Applications) are acceptable. This permits a student to finish quite readily in one year on the Cooperative Plan. Students from Power Systems Programs at other universities are welcome to explore this option with the Director of the Power Systems Engineering Program.

A student in the one year cooperative program (with 8 q.h. of credits towards the M.S. prior to the start of the sixth year) would take the following program.

Fall Quarter		Credits	Spring Quarter		Credits
3.827	Linear Systems Analysis	4	3.931	Power System Planning	4
3.928	Analysis of Power Systems	4	3.938	Comp. Control & Analysis in Power Systems	4
3.990	Seminar	2	3.991	Seminar	2
	Electives	6-8		Electives	4-6
		16-18			14-16

Total Must Equal 32

Students planning a part-time program (evening) should consult the listing under Part-time Program for their requirements.

Electives

For electives, all power students should consider selections from the list below. These are marked as day (D) or evening (E) and by quarter offered. Other suitable graduate courses are possible with the approval of the Director of the Power Systems Engineering Program.

Course Number	Course	Day or Evening	Quarter	Credits
2.920, 2.921	Direct Energy Conv.	E		2 ea.
2.932, 2.933, 2.934	Pollution Probs. from Comb.	E	F,W,S	2 ea.
2.935, 2.936	Pwr. Plant Econ. & Design	E	F,W	2 ea.
3.810, 3.811, 3.812	Therm. Fusion Ener. I, II, III	E	F,W,S	2 ea.
3.930	Pwr. Syst. Planning	E	S	2
3.931	Pwr. Syst. Planning	D	S	4
3.932	Pwr. Syst. Protection	E	F	2
3.933	Pwr. Syst. Transients	E	W	2
3.935, 3.936, 3.937	Computers in Pwr. Syst.	E	F,W,S	2 ea.
3.938	Computer Control & Anal. in Pwr. Syst.	D	S	4
3.940, 3.941, 3.942	Electric Mach.	E	F,W,S	2 ea.
3.943	Adv. Pwr. Lab	D	by arrangement	
3.944	Special Topics in Pwr.	D	by arrangement	
3.945	Pwr. Syst. Trans. Stab.	E	F	2
3.946	MHD Energy Conv.	E	W	2
3.947	H.V.D.C. Pwr. Trans.	E	S	2

Part-Time Program Electrical Engineering

Admission

The admission requirements for the part-time program leading to the degree of Master of Science in Electrical Engineering are the same as for the full-time program, but students may progress according to their abilities and the time available.

All graduate courses presuppose mastery of the subject matter of a modern, fully accredited curriculum in electrical engineering. Applicants who have not taken further academic work for some time since they received their bachelor's degree may be required to take graduate courses to satisfy any deficiencies. For this purpose, the following courses are available:

	Credits
3.975 Precs of Modern Electrical Engineering I 	2
3.976 Precs of Modern Electrical Engineering II 	2
3.977 Precs of Modern Electrical Engineering III 	2
3.978 Precs of Modern Electrical Engineering IV 	2

These courses carry graduate credit but a maximum of four quarter hours of credit from this group may be used as elective credit in the degree program.

Program

Forty quarter hours of academic work are required for the master's degree of which 16 quarter hours of credit are specified as follows:

Required Courses		Credits
3.825	Linear Systems Analysis II-A	2
3.826	Linear Systems Analysis II-B	2
*3.840	Linear Active Circuits I-A	2
*3.841	Linear Active Circuits I-B	2
3.875	Electromagnetic Theory A	2
3.876	Electromagnetic Theory B	2
3.8C1	Mathematical Methods in Electrical Engineering I-A and	2
3.8C2	Mathematical Methods in Electrical Engineering I-B or	2
3.8C4	Mathematical Methods in Electrical Engineering II-A and	2
3.8C5	Mathematical Methods in Electrical Engineering II-B or	2
3.900	Applied Probability and Stochastic Processes A .. and	2
3.901	Applied Probability and Stochastic Processes B ..	2

Students lacking the necessary prerequisites for 3.8C1 or 3.8C4 may be required to take undergraduate courses 3.292 or 3.293 to clear this deficiency. By petition, these courses may carry graduate credit.

Electives

In addition to the required course work each student is expected to select a major and a minor area from the list given below. Ten quarter hours of credit must be taken in the major area and six quarter hours of credit taken in the minor area. The area or areas to which a course is assigned is indicated in the following listings. Not every course is assigned to an area. They may be used as one of the free elective courses. Eight quarter hours of credit are free electives which may be selected from graduate courses in sciences or other engineering departments for which the student has the necessary preparation.

Subject Areas

1. Circuits and Systems		
3.830	3.838	3.911
3.831	3.839	3.912
3.832	3.843	3.950
3.833	3.845	3.951
3.834	3.860	3.952
3.835	3.861	3.953
3.837	3.910	3.954

* Evening part-time students who wish to major in Power Systems should substitute 3.925, 3.926 and 3.927, Power Circuit Analysis (2 credits per quarter) for 3.840 and 3.841.

2. Computer Science

3.837	3.935
3.860	3.936
3.861	3.937
3.892	3.967
3.893	3.968
3.894	3.969
3.895	3.972
3.898	3.973
3.899	3.974
3.8T1	3.979
3.8T2	3.985
3.8T3	3.986
3.8T7	3.987
3.8T8	3.988
3.8T9	3.989

3. Fields, Waves and Optics

3.800	3.890
3.801	3.891
3.802	3.913
3.806	3.914
3.807	3.915
3.808	3.916
3.810	3.917
3.811	3.918
3.812	3.919
3.817	3.920
3.818	3.921
3.819	3.922
3.878	3.923
3.879	3.924
3.880	3.980
3.881	3.981
3.882	3.982
3.883	3.983
3.885	3.984

4. Communications and Control

3.817	3.905
3.818	3.906
3.819	3.907
3.865	3.908
3.866	3.909
3.867	3.9C1
3.871	3.9C2
3.872	3.957
3.873	3.958
3.898	3.959
3.899	3.960
3.900	3.961
3.901	3.962
3.902	3.963
3.903	3.964
3.904	3.965

5. Physical Electronics

3.806	3.854
3.807	3.8G1
3.808	3.8G2
3.853	3.8G3

6. Power Systems

2.920	3.933
2.921	3.935
2.935	3.936
2.936	3.937
3.810	3.938
3.811	3.940
3.812	3.941
3.925	3.942
3.926	3.943
3.927	3.944
3.928	3.945
3.930	3.946
3.931	3.947
3.932	3.948

Quarter-Sequence Courses

Certain courses have an A or B after the course title. In these cases, credit will be given toward the degree only if both the A and B courses are successfully completed.

ELECTRO-OPTICS PROGRAM

The Electro-Optics Program is designed to provide the engineer and scientist with a working knowledge of current electro-optical techniques and systems. Emphasis is placed on application to industrial and research problems.

Admission

To be enrolled for this degree program, applicants must have a Bachelor of Science degree in Electrical Engineering or Physics, with an acceptable quality of undergraduate work from a recognized institution. Admission requirements are those of the regular program in electrical engineering.

Program

Forty quarter hours of academic work are required, of which 18 are specified. At least 12 additional hours of electives in optics are to be chosen from the optics elective listed below. The remaining ten hours may be selected from optics electives or from suitable courses in science or engineering.

Specified Courses	Credits
3.8C1 Math. Methods in Elec. Eng. I-A	2
or	
3.8C4 Math. Methods in Elec. Eng. II-A	2
3.8C2 Math. Methods in Elec. Eng. I-B	2
or	
3.8C5 Math. Methods in Elec. Eng. II-B	2
3.914 Electro-Optics I	2
3.915 Electro-Optics II	2
3.916 Fourier-Optics I	2
3.917 Fourier-Optics II	2
3.918 Experimental Optics I	2
3.919 Experimental Optics II	2
3.920 Experimental Optics III	2

Optics Electives	Credits
3.806 Lasers I	2
3.807 Lasers II	2
3.808 Laser Applications	2
3.913 Optical Storage and Display	2
3.921 Optical Properties of Matter I	2
3.922 Optical Properties of Matter II	2
3.923 Optical Properties of Matter III	2
3.924 Advanced Topics in Electro-Optics	2
3.980 Optical Instrument Design Concepts	2
3.981 Principles of Optical Detection I	2
3.982 Principles of Optical Detection II	2
3.983 Fourier Optics III	2
3.984 Spectroscopic Instrumentation	2

MODEL PROGRAM IN ELECTRO-OPTICS

First Year		Credits	Second Year		Credits
3.8C4	Math. Meth. in		3.915	Electro-Optics II	2
	Elec. Eng. II-A	2	3.916	Fourier Optics I	2
3.8C5	Math. Meth. in		3.917	Fourier Optics II	2
	Elec. Eng. II-B	2	3.918	Experimental Optics I . .	2
3.914	Electro-Optics I	2	3.919	Experimental Optics II	2
3.806	Lasers I	2	3.920	Experimental Optics III	2
3.807	Lasers II	2			
3.808	Laser Applications . . .	2			
		<hr/> 12			<hr/> 12

Third Year		Credits
3.913	Optical Storage and Display	2
3.921	Optical Properties of Matter I	2
3.922	Optical Properties of Matter II	2
3.981	Prin. Optical Det. I . . .	2
3.982	Prin. Optical Det. II . .	2
3.984	Spectroscopic Instr. . .	2
		<hr/> 12

Four additional hours of electives are required for a total of 40 credits for the degree.

Course Prerequisites

The prerequisites suggested for each course are given so that the student will receive full benefit from the course. In case of doubt, the student should consult the Director of the Electro-Optics Program or the course instructor.

COMPUTER SCIENCE MAJOR

The Computer Science Program is structured to provide a curriculum of study in computer science and engineering leading to the degree of Master of Science in Electrical Engineering, or Master of Science, with a major in Computer Science.

Admission

To be enrolled for this degree program, applicants must have obtained a Bachelor of Science degree in engineering, mathematics, or the physical sciences from a recognized college or university and must present satisfactory evidence of ability to pursue graduate study.

Program

Forty quarter hours of academic work are required, of which 14 are specified and 26 are elective.

Specified Courses	Credits
3.893 Digital Computer Programming I	2
3.894 Digital Computer Programming II	2
3.895 Digital Computer Programming III	2
3.972 Electronic Digital Computers I	2
3.973 Electronic Digital Computers II	2
3.8T1 Numerical Methods and Computer Applications I	2
3.8T2 Numerical Methods and Computer Applications II	2

Electives

Sixteen quarter hours of credit must be chosen from the following list of courses. It is urged that students take both of the courses in any two-quarter sequence they elect, and at least two courses in any three-quarter sequence they elect.

3.837	Introduction to Graph Theory
3.898	Combinatorial & Optimization Techniques I
3.899	Combinatorial & Optimization Techniques II
3.8T3	Numerical Methods and Computer Applications III
3.8T7	Digital Filtering I
3.8T8	Digital Filtering II
3.904	Error Correcting Coding
3.908	Special Topics in Communication Theory
3.967	Switching Circuits I
3.968	Switching Circuits II
3.969	Switching Circuits III
3.974	Electronic Digital Computers III
3.985	Fundamentals of Automatic Digital Computation I
3.986	Fundamentals of Automatic Digital Computation II
3.987	Fundamentals of Automatic Digital Computation III
3.988	Special Topics in Computer Science
3.989	Computer Peripherals
3.995	Thesis
3.998	Special Problems in Electrical Engineering
5.911	Linear Programming
5.916	Engineering Analysis Utilizing Data Processing
5.941	Management Information Systems

Students must take sufficient electrical engineering departmental courses to total 30 of the 40 quarter hours required for the degree.

Thesis

A thesis carrying six credits may be elected with the approval of the chairman of the department. If the thesis option is approved, this work is done in the second half of the program.

THE DOCTOR'S DEGREE**Full-Time Program**

The following material outlines the procedures for admission to the doctoral program and the steps necessary to qualify for the Ph.D. degree. For further information applicants should write to the Secretary, Department of Electrical Engineering.

Admission

Students who are interested in pursuing a doctor's program, should contact the Electrical Engineering Department to request an application. Completed applications, together with transcripts of all prior work and two letters of recommendation, should be forwarded to the Electrical Engineering Department, 412 Dana Hall, no later than 1 December of the preceding year. Following evaluation of this material, the applicant will be informed whether or not he will be permitted to undertake the qualifying examination. A personal interview is not required, but a student may arrange with the Secretary of the Electrical Engineering Graduate Committee, Professor Robert N. Martin (617-437-3041), for an appointment for further program details if desired. A student who has received approval to take the qualifying examination is considered a pre-doctoral student until such time as he passes the examination. Upon successful completion of the qualifying examination he becomes a Ph.D. candidate.

Residence Requirement

The residence requirement is satisfied by one year of full-time graduate work or two consecutive years of part-time graduate work. In the latter case, a detailed time schedule must be approved by the student's adviser in order to give evidence that at least half of the time is being devoted to the requirements of the graduate school program.

Qualifying Examination

The Ph.D. qualifying examination has emerged from its role as a requirement for admission to the doctoral program to the dual purpose of, one: serving as an indicator of the student's capability for successful completion of the program, and two: serving as a guide to his adviser in developing a suitable plan of study tailored to the individual needs of the candidate.

With these goals in mind, the candidate is urged to take the qualifying examination early in his graduate program (i.e., not later than the successful completion of 40 quarter hours of graduate work).

The examination is composed of a written and an oral part, and is usually given in the spring quarter of each academic year. The written part covers the following general categories:

- (1) Circuits and Electronics
- (2) Fields, Waves, and Energy Conversion
- (3) Systems
- (4) Miscellaneous Topics in Electrical Engineering

For candidates pursuing a Ph.D. with an emphasis in either Computer Science or Modern Optics, the qualifying examination will be appropriately modified.

The oral part is designed to test general comprehension. Together, the oral and written portions of the examination review the factual knowledge of a typical undergraduate Electrical Engineering program and the understanding of that material from a more mature point of view.

If the examination is failed it may be repeated only with permission of the Graduate Committee upon recommendation of the Ph.D. Qualifying Examination Committee.

Comprehensive Examination

Within three years of his establishment of degree candidacy, the student will be required to demonstrate by means of a comprehensive examination a subject matter knowledge satisfactory for the award of the degree.

The comprehensive examination is an oral examination open to the Electrical Engineering faculty (assistant professor and above in rank) and administered by the student's Thesis Committee. Departmental faculty will be informed of the examination via a departmental notice at least one week prior to the examination. Normally the examination will be given at the time the Thesis Proposal is submitted to the Thesis Committee for approval. As part of this examination the Thesis Committee will review the student's doctoral program and his performance in graduate courses, as well as examine the student on subject matter related to his graduate studies and his thesis area.

Course Requirements

Successful completion of a doctoral program normally requires 70 quarter hours of satisfactory graduate level work exclusive of thesis research and doctoral reading courses.

Doctoral Seminar, 3.993 and 3.994 are the only required courses.

The course work must include a three-course sequence (graduate level) in each of two minor areas. Both minors must be in science, applied science, or a related area. One minor may be chosen from an area of electrical engineering outside the candidate's proposed major area.

Thesis

The candidate's thesis research shall be directed by his Thesis Adviser, whom he shall select upon establishing candidacy. The Thesis Committee shall approve the thesis in final form.

Language Requirement

The language requirement may be satisfied in French, German, or Russian. The Princeton Educational Testing Service Language Examination is used for this purpose. The examination is administered by Northeastern University annually. If necessary, it may be taken at another institution. It must be passed before the final oral examination is taken.

Final Oral Examination

This examination will be held in accordance with the departmental regulations.

THE ELECTRICAL ENGINEER DEGREE

The Department of Electrical Engineering offers the graduate professional degree usually known as the Engineer Degree. This degree, offered at a number of institutions, usually requires about one year of full-time graduate study beyond the master's degree. The official title of the degree is "Electrical Engineer".

The following material outlines the procedures for admission to the Electrical Engineer degree program and the steps necessary to qualify for the degree. For further information applicants should write to Professor Robert A. Gonsalves, Department of Electrical Engineering, Room 329, Dana Hall, Northeastern University.

Admission

Students who are interested in pursuing the Electrical Engineer degree should make application for admission to the program prior to April 1. A master's degree in electrical engineering or its equivalent and the approval of the departmental graduate committee is required for admission. In some cases, where the master's degree is not in electrical engineering, a student may be admitted to the program with the stipulation that certain deficiencies be made up without credit toward the degree.

The Engineer Degree is available on either a full-time or part-time basis.

Classification and Degree Candidacy

A student admitted to the Engineer degree program will be designated as a candidate for this degree.

Residence Requirement

The residence requirement is satisfied by two academic quarters of full-time graduate work during the same academic year or four academic quarters of half-time graduate work during a period of two consecutive academic years. In the latter case, or if the student is in the part-time program, the plan for satisfying residence requirements must be approved by the student's adviser.

Qualification and Examinations

A student must maintain a B average in order to qualify for the degree. In some instances, a student may be required to take special examinations. Such examinations will be determined in each case by the departmental graduate committee.

Course Requirements

The minimum course requirements will be 40 quarter hours beyond the master's degree, with no more than 10 quarter hours of credit out of the 40 allowed for work on the dissertation. A minimum of 20 quarter hours must be taken in electrical engineering. The student's course program must be approved by his adviser.

Dissertation

Each engineer degree student must complete a dissertation which demonstrates a high level of competence in research, development, or design in the field of electrical engineering. As a general guideline, the amount of effort normally expected will be the equivalent of about 10 quarter hours of graduate work.

Language Requirement

No foreign language is required for the Electrical Engineer degree.

Final Oral Examination

A final oral examination consisting of a defense of the dissertation may be required if the student's adviser and the departmental graduate committee so decide.

Transfer of Credits

Approval for transfer of credit may be given by the departmental graduate committee upon request from the student.

Time Limitation

After admission to the program, a maximum of five years will be allowed for completion of the degree requirements. Extension of this time limit may be granted with the approval of the departmental graduate committee.

Registration

All students must register for course work or dissertation as approved by their advisers or the departmental registration officer. After the first registration for this work, registration must be continuous unless withdrawal is allowed by the departmental committee in charge of the degree program.

chemical engineering

Admission

To be enrolled for graduate work in Chemical Engineering, applicants must have obtained a Bachelor of Science degree in Chemical Engineering, with an acceptable quality of undergraduate work, from a recognized college or university.

THE MASTER'S DEGREE

Full-Time Program on the Cooperative Plan

Forty quarter hours of academic work are required. This program may be taken on the Cooperative Plan where students enroll for academic work in the Fall and Spring Quarters of the first year and in the Winter Quarter of the second year. The other three quarters of the two academic years and the summer after the first year are available for professional employment. Students who are admitted to a master's degree program under the Cooperative Plan must complete, through satisfactory performance, each cooperative work assignment in order to be eligible for their degree.

The sequence of courses on the Cooperative Plan will normally be taken according to the following pattern:

First Academic Quarter		Credits	Second Academic Quarter		Credits
4.802	Chemical Engineering			Chemical Engineering	
	Mathematics	4		Electives	8
*4.829	Chemical Process Control	4	4.991	Thesis	5
4.891	Kinetics of Chemical Processes	4			13
4.991	Thesis	2			
		14			
Third Academic Quarter			Credits		
	Chemical Engineering				
	Electives			8	
4.991	Thesis			5	
				13	

* This course may be exchanged with a Spring Quarter elective during the 1973-74 academic year only.

Chemical Engineering Electives

The electives will normally be available according to the following schedule:

Winter Quarter

- 4.803 Numerical Techniques in
Chemical Engineering
- 4.811 Chemical Engineering
Thermodynamics
- 4.823 Transport Phenomena
- 4.840 Advanced Management
Techniques in the
Chemical Industry
- 4.890 Chemical Reactor Analysis
- 4.974 Fluid Mechanics

Spring Quarter

- 4.801 Advanced Chemical
Engineering Calculations
- 4.806 Optimization Techniques
- 4.845 Advanced Plant Design
Concepts
- 4.850 Chemical Process Pollution
Control (Water)
- 4.973 Heat Transfer

Additional course work may be substituted for the Master of Science thesis upon approval of the chairman of the department. The request for this substitution must be made at the time of acceptance to the graduate school.

Students may take the program on a continuous full-time basis to complete the degree requirements in one academic year. The sequence of courses which students take on this plan is established by the chairman of the department.

Electives

With the approval of the chairman of the department, substitutions may be made for some of the prescribed courses by other courses in the department or in other departments which give graduate work.

PART-TIME PROGRAM

The admission requirements for this program are the same as for the full-time program, but students may progress according to their ability to combine their study with their employment. Students must take sufficient day and evening chemical engineering courses so that the required courses in their major total at least 28 of the 40 quarter hours required for the degree. The remaining 12 credits may be elected from any approved courses in engineering or science for which the student has the necessary preparation. Required courses and electives for all degree candidates must be approved by the chemical engineering departmental adviser. A maximum of seven years is allowed to complete the program.

THE DOCTOR OF PHILOSOPHY DEGREE

The following material outlines the procedure for admission to the doctoral program and the steps necessary to qualify for the Ph.D. degree. For further information applicants should write to the Chairman of the Department of Chemical Engineering.

Admission

Applicants who are enrolled as candidates for the degree of Master of Science in Chemical Engineering at Northeastern University should apply in writing to the Chairman of the Department of Chemical Engineering for admission to the doctoral program. Such application must be made by April first of the year in which they expect to receive the master's degree. The departmental graduate committee will examine the record of the applicant and decide whether or not he should be allowed to take the qualifying examination.

Applicants who are enrolled for graduate work at other institutions or who have completed the requirements for the master's degree should write the chairman of the department for an application for an interview. This form, together with transcripts of all undergraduate and graduate work, must be transmitted to the chairman of the departmental graduate committee. The applicant will be notified of an interview time and, after the interview, will be advised if he should make formal application for admission to the doctoral program. Approved applicants must submit an application for admission as a doctoral candidate and two letters of recommendation not later than April first. The applicant will be notified of the acceptance of his application and the date of the qualifying examination.

Residence Requirement

The residence requirement is satisfied by one year of full-time graduate work or two consecutive years of part-time graduate work. In the latter case, a detailed time schedule must be approved by the departmental graduate committee as evidence that at least half of the time is being devoted to the requirements of the graduate school program. In general, it should be expected that at least two years of full-time work after establishment of degree candidacy will be necessary.

Degree Candidacy

Degree candidacy is established in accordance with the general graduate school regulations.

Qualifying Examination

The qualifying examination includes both written and oral parts and is normally given in the spring and the fall. The written examination, in general, will cover the following areas:

1. General Principles in Chemical Engineering Science
2. Thermodynamics and Stoichiometry
3. Mathematical Procedures and Kinetics
4. Specialized Technological Topics (to be announced)

The oral examination will test general comprehension.

A student may take any or all of the written examinations in each area and may repeat a failed examination, only once, at a later offering. The taking and successful completion of all examinations may not extend over a period greater than 13 months. Previously administered examinations will be available to formal applicants.

Comprehensive Examination

During the time in which a student is a candidate for a doctoral degree he may be required to demonstrate by means of a comprehensive examination a subject-matter knowledge satisfactory for the award of the degree.

Course Requirements

The course requirements in addition to the minimum requirements for establishing degree candidacy will be determined by the departmental graduate committee and the student in consultation with the committee.

Transfer credit will be dealt with on an individual basis by the departmental graduate committee in accordance with the general graduate school regulations.

Thesis

An individual may choose his thesis topic and supervisor as soon as he becomes a doctoral student. In most cases selection of topic will be made immediately after the student has established his candidacy for the Ph.D. degree. He will be expected to discuss with the staff their Ph.D. thesis topics offerings. After these discussions, the student shall notify the adviser, the department head, and the chairman of the departmental graduate committee in writing of his choice of thesis topic and adviser. The chairman of the departmental graduate committee after consultation with the thesis adviser shall appoint an appropriate thesis committee. This committee shall be kept informed of the progress of the thesis and will approve the thesis in its final form.

Language Requirement

The foreign language requirement may be satisfied by a reading knowledge in two languages selected from French, German, and Russian. The examinations are administered by the department and consist of translation from current scientific journals or textbooks.

Final Oral Examination

This examination is held in accordance with the general regulations of the graduate school.

THE DOCTOR OF ENGINEERING DEGREE

The following material outlines the procedure for admission to the doctoral program and the steps necessary to qualify for the Doctor of Engineering degree. For further information, applicants should write to the Chairman of the Department of Chemical Engineering.

Admission

Applicants for the Doctor of Engineering program must either be candidates for the Master of Science degree in Chemical Engineering or have completed the Master of Science program in Chemical Engineering.

Applicants need not have undertaken a master's thesis.

Applicants for the Doctor of Engineering degree must pass the doctorate qualifying examination given to applicants for the Doctor of Philosophy degree in this department.

Applicants must file application forms with the departmental graduate committee along with official transcripts of previous college work, and two letters of recommendation. Applicants will not be considered until all documents have been received. Applicants will be notified promptly as to whether or not they have been accepted.

Residence Requirement

The residence requirement is satisfied only by full-time residence for one academic year. This requirement must be fulfilled after successful completion of the qualifying examination and prior to the end of the five-year period set forth in the general regulations.

Degree Candidacy

Degree candidacy is established in accordance with the general graduate school regulations.

Qualifying Examination

The qualifying examination includes both written and oral parts and is normally given in the spring and the fall. The written examination, in general, will cover the following areas:

1. General Principles in Chemical Engineering Science
2. Thermodynamics and Stoichiometry
3. Mathematical Procedures and Kinetics
4. Specialized Technological Topics (to be announced)

The oral examination will test general comprehension.

A student may take any or all of the examinations in each area and may repeat a failed examination, only once, at a later offering. The

taking and successful completion of all examinations may not extend over a period greater than 13 months. Previously administered examinations will be available to formal applicants.

Comprehensive Examination

During the time in which a student is a candidate for a doctoral degree he may be required to demonstrate by means of a comprehensive examination a subject-matter knowledge satisfactory for the award of the degree.

Course Requirements

The course requirements, in addition to the minimum requirements for establishing degree candidacy, will be determined by the departmental graduate committee and the student in consultation with the committee.

Transfer credit will be dealt with on an individual basis by the departmental graduate committee in accordance with the general graduate school regulations.

Engineering Problem

Engineering Problem advisers will be appointed by the departmental graduate committee. Approval of the topic for the Problem rests with the Problem adviser and the committee.

The Engineering Problem is not a research problem but rather an engineering problem in depth. It may include elements of design, economics, business management principles, and process development. In general, it will not include laboratory investigations.

Normally, the Engineering Problem will be solved on campus. Under special arrangements approved by the departmental graduate committee and the adviser, a portion of the work may be performed off campus.

Regardless of the arrangements made for the Engineering Problem, no off-campus adviser will be approved. Only the Problem adviser will specify the nature and requirements of the Problem, and the findings and results remain the property of the adviser and the University to be published as they determine.

Language Requirement

There is no foreign language requirement for this degree.

Computer Ability

Ability with computer programming must be demonstrated when required.

Final Oral Examination

This examination is held in accordance with the general graduate school regulations.

industrial engineering and engineering management

The Department of Industrial Engineering offers two degrees: Master of Science in Industrial Engineering and Master of Science in Engineering Management. Either degree can be pursued on a part- or full-time basis and full-time students may elect to participate in the Cooperative Plan. Under the Cooperative Plan a student spends 9-12 months working in a field which is complementary to his academic program and professional goals. During this time he receives compensation from his employer, which is generally in line with salaries for engineers with equivalent experience.

The Master of Science in Industrial Engineering has a General Program as well as majors in Health Systems, Computer and Information Systems, and Operations Research; all of which require a thesis. The Master of Science in Engineering Management has a General Program and majors in Computer and Information Systems and Operations Research. A thesis is not a requirement for this degree. A minimum of 40 quarter hours of graduate level credit is required for either degree program.

Industrial Intern Program Leading to the MSIE

The Engineering Sponsorship program in Industrial Engineering is known as the Industrial Intern Program. The program, available to a selected group of students, is an enriched MSIE cooperative program in which the student, the University, and a cooperating employer tailor each program to individual interests. Usually the minimum academic requirements of the MSIE program will be substantially surpassed in the industrial intern option.

Through agreements with cooperating employers, students accepted for the industrial intern option will receive full tuition and living expenses for seven or eight quarters. Four of these will be spent in pro-

fessionally relevant employment. During each of these cooperative quarters, students will take independent study under the direction of a faculty member. Wherever possible, those specialized reading courses will lead toward a thesis problem statement of interest to the student, cooperative employer and the department. When this goal is achieved, the MSIE program will be completed in seven quarters. A goal of the industrial intern option is that each student's thesis be a significant independent investigation.

Admission

To be enrolled for graduate study in Industrial Engineering or Engineering Management, the applicant must have obtained a Bachelor of Science degree in an engineering field, with an acceptable quality of undergraduate work from a recognized college or university. A limited number of applicants with a Bachelor of Science degree in mathematics or a closely related science, whose preparation is considered adequate, may be permitted to pursue either program, and, upon its completion, qualify for the degree of Master of Science without specification.

Entrance to either program presupposes that students have had a basic course in each of the following areas: engineering economy, probability, engineering statistics, operations research (deterministic and stochastic), computer programming (compiler language), and accounting. Recognizing that some applicants may be deficient in certain of these subjects, the program offers the intensive courses listed below. At the time of admission to the program the adviser will specify, on the basis of the applicant's transcript, those courses on the list which the applicant must complete satisfactorily to qualify for the degree. Such specified courses are to be completed as early in the program as scheduling will permit. The courses below carry graduate credit but a maximum of six quarter hours of credit from this group may be used as elective credit toward the degree.

Course	Credits
5.808 Basic Engineering Economy	2
5.810 Industrial Accounting for Engineers	2
5.901 Basic Operations Research I (Deterministic)	2
5.902 Basic Operations Research II (Stochastic)	2
or	
5.900 Operations Research	4
Equivalent to 5.901 and 5.902	
5.913 Data Processing for Engineers (FORTRAN)	2
5.950 Engineering Statistics I or 10.8G1	2
5.951 Engineering Statistics II	2
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	14

Industrial Engineering Programs — no specified major**Required Courses**

Course	Credit	Quarter
5.803 Industrial Organizations	2	Fall
5.823 Advanced Production Analysis*	4	Fall
5.824 Case Studies in Industrial Engineering ..	2	Spring
5.909 System Engineering and Analysis	2	Spring
5.914 Advanced O.R.	4	Spring
5.992 Seminar	2	Fall
5.991 Thesis	6	All Quarters
10.592 Mathematical Statistics or 5.952 Design of Experiments I and 5.958 Design of Experiments II	4	

The remaining hours are satisfied through a suitable choice of electives at least 6 hours of which will come from one of the five areas of concentration:

Management of Technology
Operations Research and Quantitative Techniques
Production Engineering and Man/Machine Systems
Financial and Operational Controls
Computer and Information Systems

HEALTH SYSTEMS MAJOR

This major is offered on a two-year cooperative basis. Students are expected to spend at least three academic quarters as an intern or resident in training in a health-oriented organization such as a hospital or health planning agency. In addition, the thesis topic must be related to the field of health.

Required Courses

Course	Credit	Quarter
5.823 Advanced Production Analysis*	4	Fall
5.860 Health Care Organization and Management	2	Fall
5.865 Case Studies in Health Systems	2	Spring
5.909 Systems Engineering and Analysis	2	Winter
5.914 Advanced O.R.	4	Spring
5.991 Thesis	6	All Quarters
5.992 Seminar	2	Fall
39.9H1 Economics of Health and Welfare	2	Winter

The remaining hours should be satisfied through appropriate choice of electives.

* Not required for students with a degree in Industrial Engineering

ENGINEERING MANAGEMENT

(No specified major)

To assure adequate preparation for management of technological activities, all students who do not elect the Computer Systems or Operations Research major must earn the minimum number of credits indicated in each of the five categories listed below:

Category	Minimum Credits
a. Management of Technology	8 including 5.801
b. Operations Research and Quantitative Techniques	8
c. Production Engineering	4
d. Financial and Operational Controls	4 including 5.830
e. Computer and Information Systems	4
	<hr/>
TOTAL	28

The remaining 12 quarter hours required for the degree may be considered as free electives. These may be taken within the course offering for this program or from any courses in graduate engineering and mathematics for which the student has adequate preparation. Up to six quarter hours may be elected in other graduate schools subject to the approval of the adviser for this program and the director of the graduate school in which the course is offered. Students desiring courses in such subjects as economics, business law, labor relations, or marketing, should consult the *Graduate School of Business Administration Catalog*.

Courses in the five categories from which students must select to meet the indicated minimum total of 28 quarter hours of credit are listed below. Unless otherwise specified, all courses are for two quarter hours of credit.

a. Management of Technology

5.801 & 5.802	Analysis of the Industrial Enterprise I and II
5.803	Industrial Organizations
5.812	Management of Technical Innovation
5.814	Development of Engineering Managers
5.815	Legal Aspects of New Technology
5.816	Industrial Psychology for Engineers
5.820	Personnel Administration for Engineers
5.823	Advanced Production Analysis (4 q.h.)
5.841	Engineering Project Administration

b. Operations Research & Quantitative Techniques

5.903	Inventory Control and Production Planning
5.904	Queuing Theory and Its Applications
5.905	Analysis with Simulation

5.909	Systems Engineering and Analysis
5.911	Linear Programming
5.912	Network Planning and Control
5.914	Advanced Operations Research (4 q.h.)
5.916	Engineering Analysis Utilizing Data Processing
5.952	Design of Experiments I
5.953	Statistical Decision Theory
5.954	Advanced Quality Control
5.955	Reliability and Maintainability Applications
5.956	Mathematical Theory of Reliability
5.957	Designing for Reliability
5.958	Design of Experiments II

c. Production Engineering and Man/Machine Systems

5.806	Production Forecasting
5.817	Advanced Work Design
5.819	Human Factors in Man/Machine Systems
5.822	Product Design and Value Analysis
5.823	Advanced Production Analysis (4 q.h.)
5.825	Topics in Production Engineering
5.903	Inventory Control and Production Planning
5.912	Network Planning and Control
5.954	Advanced Quality Control
5.955	Reliability and Maintainability Applications
5.956	Mathematical Theory of Reliability
5.957	Designing for Reliability

d. Financial and Operational Controls

5.805	Industrial Budgeting for Engineers
5.809	Advanced Engineering Economy
5.811	Cost Accounting for Engineers
5.830 & 5.831	Financial Management I and II
5.930	Basic Computer Systems Technology
5.940	Basic Information Systems Technology
5.941	Management Information Systems

e. Computer and Information Systems

5.905	Analysis with Simulation
5.916	Engineering Analysis Utilizing Data Processing
5.930	Basic Computer Systems Technology
5.931	Computer Systems
5.932	Advanced Computer Systems
5.940	Basic Information Systems Technology
5.941	Management Information Systems
5.942	Advanced Management Information Systems
5.943	Management Decision Systems
3.893	Digital Computer Programming I

3.894	Digital Computer Programming II
3.895	Digital Computer Programming III
3.972	Electronic Digital Computers I
3.973	Electronic Digital Computers II
3.974	Electronic Digital Computers III
3.985	Fundamentals of Automatic Digital Machines I
3.986	Fundamentals of Automatic Digital Machines II
3.987	Fundamentals of Automatic Digital Machines III
3.989	Computer Peripherals

COMPUTER AND INFORMATION SYSTEMS MAJOR

The Computer and Information Systems (C & IS) Major is designed to meet the needs of three distinct but related professional areas — computer systems, information systems, and management.

A unique two track curriculum offers sets of courses in computer systems and information systems, each track tailored for particular specialties but integrated with material from the other track for general management. The computer system track focuses on basic concepts and their implementation in hardware and software systems. The information systems track focuses on supporting the management decision process — evaluation, analysis, and design of management information and decision systems.

The number of courses required from each track depends upon the students professional objectives. Unique programs can be designed in consultation with the adviser. All C & IS majors will be expected to take the ten or sixteen quarter hours of courses listed below as general requirements. In addition they are required to take at least sixteen quarter hours from category (e), computer information systems. It is suggested that students within this major follow one of the two course tracks listed below as a portion of the sixteen quarter hour requirement. Exception to these regulations must be approved in a consultation with an adviser.

General Requirements

	Minimum Credits
Management of Technology;	
5.801 Analysis of the Ind. Enterprise I	2
Operation Research & Quantitative Techniques	
5.905 Analysis with Simulation	2
Elective within category	2
Production Engineering	
Elective within category	2
Financial Controls	
5.830 Financial Management I	2
Thesis	
5.991 (Required of Industrial Engineering majors) ..	6
	<hr/> 10 or 16

Two Track Course List**Computer Systems Track**

5.930	Basic Computer Systems Technology
5.931	Computer Systems
5.932	Advanced Computer Systems

Information Systems Track

5.940	Basic Information Systems Technology
5.941	Management Information Systems
5.942	Advanced Management Information Systems
5.943	Management Decision Systems

OPERATIONS RESEARCH MAJOR

The following courses are required of students electing the Operating Research major:

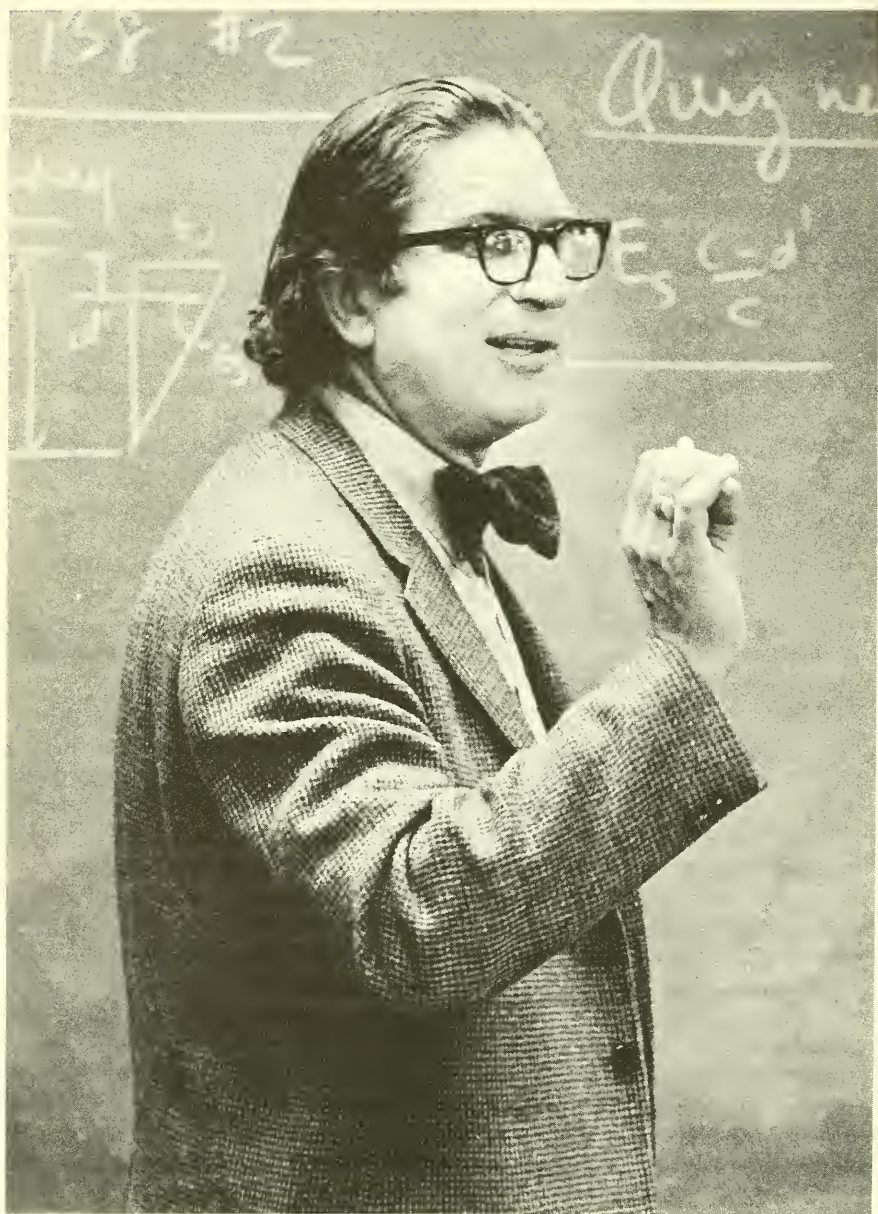
	Credits
*10.8G2 Probability II	2
5.801 Analyses of the Industrial Enterprise	2
5.830 Financial Management I	2
5.914 Advanced Operations Research	4
5.991 Thesis (required of Industrial Engineer majors) ..	6
	<hr/> 10 or 16

In addition to the above required courses, the student must earn the minimum number of credits in each of the categories listed below.

Category	Minimum Credits
b. Quantitative Techniques	8
c. Production Engineering	4
e. Computer Systems	4
Math-oriented courses (listed below)	4
5.910 Analytical Techniques for Engineers	
*10.8B4 Advanced Calculus I	
*10.8B5 Advanced Calculus II	
*10.8B6 Advanced Calculus III	
*10.8G8 Stochastic Processes I	
*10.8G8 Stochastic Processes II	

The remaining hours required for the degree may be considered as free electives. These may be taken within the course offerings for this program or from any courses in graduate engineering or mathematics for which the student has adequate preparation. Up to six quarter hours may be elected in other graduate schools subject to the approval of the adviser for this program and the director of the graduate school in which the course is offered. Students desiring courses in such subjects as economics, business law, labor relations, or marketing should consult the catalog of the Graduate School of Business Administration.

*See Graduate School of Arts and Science Catalogue.



description of courses

All courses carry two quarter hours of credit unless otherwise noted. Not all courses are offered every year. Refer to the Graduate School of Engineering circular issued about July 1 each year for the courses to be offered in the new academic year and the times at which they are scheduled to meet.

CIVIL ENGINEERING

1.206 Applied Probability Theory for Civil Engineers (4 q.h. credits)

The basic elements of probability theory and their use via the solution of various civil engineering problems encountered in fluid mechanics, construction management, structures, transportation, etc. Probability of events, random variables and distribution, derived distribution, expectation, and common probability models. *Prep. Admission to Graduate School of Engineering.*

1.800 Systems Analysis (4 q.h. credits)

Systems Analysis involves the use of quantitative and economic techniques for allocation of resources in the planning and design of large physical systems as encountered in transportation and environmental engineering. Topics include the calculus method for constrained and unconstrained optimization problems, linear programming, dynamic programming, marginal analysis, sensitivity analysis and decision analysis for selection. *Offered yearly, fall quarter, days*

1.803 Traffic Flow Theory I

Statistical methods in traffic flow theory; probability models, hypothesis testing and its use, queuing theory and simulation techniques. *Prep. 5.950, Engineering Statistics I or equivalent.* *Offered 1975-76, fall quarter*

1.804 Traffic Flow Theory II

Deterministic methods in traffic flow theory; car following models; various methods of analogy, capacity and level of service. *Prep. 1.803, Traffic Flow Theory I.* *Offered 1975-76, winter quarter*

1.805 Traffic Flow Theory (4 q.h. credits)

This course, offered days, embodies the material in 1.803 and 1.804, Traffic Flow Theory I and II. *Prep. 5.950, Engineering Statistics I or equivalent.*

Offered yearly, winter quarter

1.806 Urban Transportation Analysis (4 q.h. credits)

This course, offered days, embodies the material in 1.801 and 1.802, Urban Transportation Analysis I and II. *Prep. 5.910, Analytical Techniques for Engineers or equivalent.* *Offered yearly, winter quarter*

1.810 Systems Analysis I

Systems Analysis involves the use of quantitative and economic techniques for allocation of resources in planning and design of large physical systems as encountered in transportation, environmental, and structural engineering. Topics include calculus method for constrained and unconstrained optimization problems, marginal analysis, and linear programming. Offered 1975-76, fall quarter

1.812 Systems Analysis II

A continuation of 1.810 and includes the following topics: sensitivity analysis, dynamic programming, and decision analysis for selection. *Prep. 1.810, Systems Analysis I.* Offered 1975-76, winter quarter

1.819 Environmental Impacts of Urban Transportation (4 q.h. credits)

Examination of the human response to noise, water and air pollution; physical effects of pollution in relation to source-receptor configurations and urban scale meteorology; laboratory and field techniques used in measuring pollutant levels; government regulations and guidelines and their effect on urban transportation planning. *Prep. Admission to Graduate School of Engineering.*

Offered 1974-75, fall quarter, days

1.820 Transportation Engineering (2 q.h. credits)

Description and evaluation of different modes of transportation existing and proposed; their performance and cost characteristics; design, performance, and selection criteria for vehicles and roadbeds. *Prep. Admission to Graduate School of Engineering.*

1.824 Civil Engineering Materials I (2 q.h. credits)

The behavior of civil engineering materials subjected to various loading and environmental conditions. Includes atomic structure and bonding, elastic and plastic behavior of metals, strength and durability of wood, concrete, and bituminous mixes.

1.825 Civil Engineering Materials II (2 q.h. credits)

Continuation of 1.824. Includes composite materials, phase transformations, corrosion, strengthening mechanisms.

1.834 Transportation Analysis and Planning (4 q.h. credits)

Principles of the analysis of transportation networks through the use of the conventional forecasting model system; evaluation of alternative transportation networks and their components; basic aspects of traffic analysis.

1.837 Interdisciplinary Urban Transportation Seminar

Review and presentation of research and public policy on broad topics in transportation. Guest lecturers and formal paper presentations. *Prep. Permission of Civil Engineering Department.* Offered 1974-75, spring quarter

1.838 Master's Report (Transportation) (4 q.h. credits)

An individual effort in an area selected by student and adviser resulting in a definitive report. *Prep. Permission of the Civil Engineering Department.*

Offered yearly, all quarters

1.839 Thesis (Master's Degree) (6 q.h. credits)

Analytical and/or experimental work conducted by arrangement with and under the supervision of the department. *Prep. Permission of the Civil Engineering Department.*

Offered yearly, all quarters

1.841 Structural Analysis I

Review of basic principles of structural analysis, determinacy, indeterminacy, stability. Introduction to energy methods including virtual work and Castiglino's Theorem. *Prep. Differential and Integral Calculus plus Theory of Structures.*
Offered yearly, fall quarter

1.842 Structural Analysis II

Contemporary methods of structural analysis with emphasis on lateral load analysis of multistory structures. A complete treatment of moment distribution including non-prismatic members, axial load, and shear distribution. *Prep. 1.841 Structural Analysis I.*
Offered yearly, winter quarter

1.843 Structural Analysis III

Introduction to matrix methods of structural analysis, including stiffness and flexibility methods. *Prep. 1.842, Structural Analysis II.*
Offered yearly, spring quarter

1.844 Structural Analysis IV

Introduction to advanced structural mechanics, emphasis on theory of elasticity, and development of finite element method of analysis. *Prep. 1.843 Structural Analysis III.*
Offered 1974-75, fall quarter

1.847 Structural Analysis (4 q.h. credits)

This course, offered days, embodies the material in 1.841 and 1.842 — Structural Analysis I and II. *Prep. Differential and Integral Calculus plus Theory of Structures.*
Offered yearly, fall quarter

1.849 Model Analysis

Development of the principles of similitude to establish the relationship between behavior in the model and the full-sized structure. Review of techniques to fabricate, to load, and to instrument models. Application and use of strain gauges. The laboratory portion is devoted to model analysis of a complex structure. *Prep. Admission to program and approval of instructor.*
Offered 1975-76, spring quarter

1.850 Structural Dynamics I

Analysis by exact and approximate methods of structures subjected to dynamic loads. *Prep. 1.843, Structural Analysis III.*
Offered 1974-75, winter quarter

1.851 Structural Dynamics II

Continuation of 1.850 with application to the analysis of structures subjected to blast loads and seismic loadings. *Prep. 1.850, Structural Dynamics I.*
Offered 1974-75, spring quarter

1.853 Concrete Structures I

Review of basic characteristics of concrete. Structural forms appropriate for reinforced and prestressed concrete. Prestressed concrete design. *Prep. Reinforced Concrete Design and Structural Analysis.*
Offered yearly, fall quarter

1.854 Concrete Structures II

Continuation of Concrete I. Additional topics on prestressed concrete design, yield line theory, and folded plate design. *Prep. 1.853 Concrete Structures I.*
Offered yearly, winter quarter

1.855 Concrete Structures III

Analysis and design of thin-shell concrete structures including domes, cylindrical shells, and hyperbolic paraboloids. *Prep. 1.854 Concrete Structures II.*

Offered yearly, spring quarter

1.856 Structural Analysis (4 q.h. credits)

This course, offered days, embodies the course content offered in 1.843, Structural Analysis III and 1.844, Structural Analysis IV. *Prep. 1.847, Structural Analysis.*

Offered yearly, spring quarter

1.857 Structural Dynamics (4 q.h. credits)

This course, offered days, embodies the material in 1.850 and 1.851 — Structural Dynamics I and II. *Prep. 1.856, Structural Analysis.*

Offered yearly, winter quarter

1.858 Concrete Structures (4 q.h. credits)

This course, offered days, embodies the material in 1.853 and 1.854 — Concrete Structures I and II. *Prep. Reinforced Concrete Design.*

Offered yearly, fall quarter

1.859 Structural Stability

Elastic and inelastic stability of structures including beams, columns, plates, and shells. *Prep. 1.843, Structural Analysis III.* Offered 1974-75, fall quarter

1.861 Design of Structures I

An advanced course in elastic design in structural steel. Design problems involving braced and rigid frame structures subject to gravity, wind, and seismic loads are considered. *Prep. 1.842, Structural Analysis II.*

Offered 1975-76, fall quarter

1.862 Design of Structures II

An advanced course in analysis and design in structural steel with emphasis on plastic behavior including rigid frame buildings and braced multistory frame buildings. *Prep. 1.861, Design of Structures I.* Offered 1975-76, winter quarter

1.863 Design of Structures III

Advanced problems in elastic and plastic design of structural steel. Topics include curved girders and cable supported structures. *Prep. 1.862, Design of Structures II.*

Offered 1975-76, spring quarter

1.864 Design of Structures (4 q.h. credits)

This course, offered days, embodies the material in 1.862 and 1.863 — Design of Structures II and III. *Prep. 1.861, Design of Structures I.*

Offered yearly, winter quarter

1.871 Engineering Properties of Soils I

Review of phase relationships, soil consistency, etc.; permeability and capillarity; effective stress concept, analysis of seepage in porous media; stress distribution; introduction to settlement analysis. *Prep. Undergraduate course in basic soil mechanics.*

Offered yearly, fall quarter

1.872 Engineering Properties of Soils II

A continuation of course 1.871. The course covers consolidation theory and settlement analysis; shear strength properties of soils; stability analysis of open and braced cuts; and earth pressure theory and analysis. *Prep. 1.871, Engineering Properties of Soils I.*

Offered yearly, winter quarter

1.873 Soils Testing Laboratory

Emphasis on the soil behavior aspects of consolidation theory, settlement analysis, and shear strength. Approximately one-half of the term is devoted to laboratory studies in soil compaction, consolidation, and shear strength. *Prep. 1.871, Engineering Properties of Soils I.* Offered yearly, spring quarter

1.874 Soil Mechanics and Foundation Engineering I

Soil compressibility; case studies of deep-seated settlement; allowable settlements; preloading concepts; bearing capacity; subsurface exploration. *Prep. 1.872, Engineering Properties of Soils II.* Offered 1974-75, fall quarter

1.875 Soil Mechanics and Foundation Engineering II

Design principles of footings, mats and floating foundations; pile foundations; selection of foundation scheme; case studies. *Prep. 1.874, Soil Mechanics and Foundation Engineering I.* Offered 1974-75, winter quarter

1.876 Soil Mechanics and Foundation Engineering III

Lateral earth pressure theory; analysis and design of retaining walls, anchored bulkheads and braced cofferdams; dewatering; observational approach to design; foundation performance with case studies; cellular cofferdams. *Prep. 1.875, Soil Mechanics and Foundation Engineering II.*

Offered 1974-75, spring quarter

1.877 Engineering Properties of Soils (4 q.h. credits)

This course, offered days, embodies the material in 1.871 and 1.872—Engineering Properties of Soils I and II. *Prep. Undergraduate course in basic soil mechanics.* Offered yearly, fall quarter

1.878 Foundation Engineering (4 q.h. credits)

This course, offered days, embodies the course content offered in 1.874 and 1.875—Soil Mechanics and Foundation Engineering I and II. *Prep. 1.877 Engineering Properties of Soils.* Offered yearly, spring quarter

1.882 Engineering Geology I

Review of minerals, selected topics in historical and structural geology related to engineering geology; origin and occurrence of various rock types, geologic structures, faulting and joint systems; weathering of rock and weathering products, glaciation, geologic mapping and environmental aspects. *Prep. Undergraduate course in geology.* Offered 1975-76, fall quarter

1.884 Rock Mechanics I

Interrelationship with other disciplines; index properties; classification systems; laboratory tests; state of stress and stress distribution. *Prep. 1.882, Engineering Geology I.* Offered 1975-76, winter quarter

1.885 Rock Mechanics II

Behavior of rock under combined stresses; pore pressure effects; failure theories; in-site deformation modulus and shear strength characteristics; field testing. *Prep. 1.884, Rock Mechanics I.* Offered 1975-76, spring quarter

1.892 Numerical Methods in Structural Mechanics I

Formulation and numerical solution of civil engineering problems in structural mechanics. Emphasis will be on lumped parameter systems. Equilibrium, eigenvalue, and propagation type problems will be covered. *Prep. 1.843, Structural Analysis III.* Offered 1974-75, winter quarter

1.893 Numerical Methods in Structural Mechanics II

Continuation of 1.892. *Prep. 1.892, Numerical Methods in Structural Mechanics I.*
Offered 1974-75, spring quarter

1.894 Numerical Methods in Structural Mechanics (4 q.h. credits)

This course, offered days, embodies the material in 1.892 and 1.893 — Numerical Methods in Structural Mechanics I and II.

Offered yearly, spring quarter

1.897 Master's Report (Structural) (4 q.h. credits)

An individual effort consisting of laboratory and/or literature investigation and analysis or advanced design of a project in an area of structural engineering selected by student and adviser resulting in a definitive report. *Prep. Permission of the Civil Engineering Department.*

Offered yearly, all quarters

1.898 Special Topics in Structural Engineering (2 q.h. credits)

An individual effort in an area selected by student and adviser resulting in a definitive report. Open to day students only. *Prep. Admission to Graduate School of Engineering.*

Offered yearly, all quarters

1.899 Thesis (Master's Degree) (8 q.h. credits)

Analytical and/or experimental work conducted by arrangement with and under supervision of the department. *Prep. Permission of the department.*

Offered yearly, all quarters

1.901 Hydraulics I

Mechanical properties of fluids — fluid statics, continuity, energy relationships (Bernoulli and Euler equations), momentum, dimensional analysis, steady flow in conduits under pressure, pipe systems. *Prep. Undergraduate course in hydraulics.*

Offered yearly, fall quarter

1.902 Hydraulics II

Open channel flow — energy relationships, critical flow, controls, momentum principles, flow resistance, uniform flow, gradually varied flow, local phenomena. *Prep. 1.901, Hydraulics I.*

Offered yearly, winter quarter

1.903 Hydraulics III

Open channel flow — channel transitions; unsteady flow; potential flow — velocity potential function and stream function; selected topics in hydraulics and fluid mechanics. *Prep. 1.902, Hydraulics II.*

Offered yearly, spring quarter

1.904 Hydraulics (4 q.h. credits)

This course, offered days, embodies substantially the material in 1.902 and 1.903 — Hydraulics II and III. *Prep. Undergraduate course in hydraulics.*

Offered yearly, winter quarter

1.905 Water Resources Planning I

Hydrologic cycle; precipitation studies including data adjustment, spatial and temporal variability, intensity-duration-frequency relationships; abstractions of water due to evapotranspiration and infiltration; groundwater flow, including flow nets and well hydraulics; runoff studies including data adjustment, runoff volume, peak flows, unit hydrographs, flood formulas, and drainage design. *Prep. Admission to Graduate School of Engineering.*

Offered yearly, fall quarter

1.906 Water Resources Planning II

Drainage and river basin morphology; hydrogeology; streamflow and streamflow routing; storage models of runoff; reservoir routing and design; floods and flood control; case studies in hydrology; water resources planning including water law and policy, urbanization and its effects, reservoir system operation and regulation, alternative uses of water resources, and multipurpose projects; conservation and reuse of water. *Prep. 1.905, Water Resources Planning I.*

Offered yearly, winter quarter

1.907 Water Resources Planning III

Statistical studies applied to hydrologic data, including basic statistics; frequency and probability distributions; methods of frequency analysis; multiple linear regression and correlation analysis; introduction to mathematical modeling of hydrologic processes including discussion of deterministic and stochastic processes; time series analysis, Markov chains; synthetic hydrology and simulation. *Prep. 1.906, Water Resources Planning II.*

Offered yearly, spring quarter

1.910 Water and Wastewater Treatment I

Water quality, water impurities and effects, the theory and practice of water treatment, and the elements of design of water treatment works including intake facilities, wells, filtration, coagulation, sedimentation, softening, iron and manganese removal, disinfection, and fluoridation. *Prep. 1.921, Environmental Chemistry II, or equivalent.*

Offered yearly, fall quarter

1.911 Water and Wastewater Treatment II

Waste characteristics, the theory and practice of wastewater treatment and disposal, and the elements of design of primary and secondary treatment works, including screening, grit removal, sedimentation, biological treatment processes, sludge digestion and disposal, stabilization ponds, and disinfection. *Prep. 1.910, Water and Wastewater Treatment I.*

Offered yearly, winter quarter

1.912 Water and Wastewater Treatment III

Salt water conversion, advanced wastewater treatment, and other special problems in water and wastewater characteristics and treatment, including corrosion control, pumping and storage, application of chemicals, radioactive wastes, thermal pollution, and treatment plant instrumentation. *Prep. 1.911, Water and Wastewater Treatment II.*

Offered yearly, spring quarter

Offered yearly, winter quarter, days

1.913 Industrial Waste Disposal

Evaluation of industrial waste problems and development of process design for the required treatment facilities; study of various manufacturing processes and their wastewater problems; industrial waste survey techniques; characteristics of industrial wastes; waste reduction methods; physical, chemical, biological, and advanced treatment methods; industrial wastewaters and disposal and treatment of industrial solids and liquids. *Prep. 1.912, Water and Wastewater Treatment III and 1.921, Environmental Chemistry II.*

Offered yearly, fall quarter

1.914 Water & Wastewater Treatment (4 q.h. credits)

This course, offered days, embodies the material in 1.910 and 1.911 — Water and Wastewater Treatment I and II. *Prep. Two undergraduate semesters of hydraulics.*

Offered yearly, fall quarter

1.920 Environmental Chemistry I

Analytical chemistry principles are studied with reference to environmental engineering applications. The chemistry of processes such as coagulation, iron and manganese removal, ion exchange, softening, and disinfection are included. The principles of spectroscopy and polarography are also discussed. *Prep. Two semesters of general chemistry.*

Offered yearly, fall quarter

1.921 Environmental Chemistry II

A continuation of 1.920 including gas transfer, oxidation and reduction, and radiation chemistry. Reaction rates with reference to environment engineering applications such as BOD are discussed. Topics in organic chemistry and instrumental analysis are included. *Prep. 1.920, Environmental Chemistry I.*

Offered yearly, winter quarter

See NOTE below regarding courses 1.921, 1.922, and courses 1.930, 1.931.

1.922 Environmental Bacteriology

A study of bacteriology with emphasis on environmental engineering applications. The course includes cell structure, nutrition, morphology, growth, reproduction, and metabolism of bacteria. Effects of environmental factors including inhibition, killing, and natural habitats are discussed. Methods of quantitative bacteriology are also covered. *Prep. 1.921, Environmental Chemistry II.*

Offered yearly, spring quarter

1.923 Environmental Chemistry (4 q.h. credits)

This course, offered days, embodies the material in 1.920 and 1.921 — Environmental Chemistry I and II. *Prep. Two semesters of general chemistry.*

Offered yearly, fall quarter

1.930 Environmental Analysis I

A laboratory course for the analytical measurement of environmental conditions. Physical, chemical, and biological characteristics are determined by the latest analytical methods with emphasis on their fundamental principles and operational techniques. Interpretation of analytical results for practical applications is also stressed. *Prep. 1.921, Environmental Chemistry II.*

Offered yearly, winter quarter

NOTE: It is strongly recommended that this course and 1.931 be taken simultaneously with 1.921 and 1.922.

1.931 Environmental Analysis II

The laboratory analyses are continued with emphasis on the chemical and biological analyses associated with treatment methods; microbiological techniques utilizing microscopy and membrane filter preparation; emphasis on environmental reports. *Prep. 1.930, Environmental Analysis I.*

Offered yearly, spring quarter

1.933 Environmental Analysis (4 q.h. credits)

This course, offered days, embodies the material in 1.930 and 1.931 — Environmental Analysis I and II. *Prep. 1.923, Environmental Chemistry taken simultaneously.*

Offered yearly, fall quarter

1.935 Unit Operations in Environmental Engineering I

Laboratory scale unit operations illustrating the physical, chemical and biological principles involved in water and wastewater treatment. The aim is to obtain criteria for system design. Topics include disinfection, water softening, sedimentation, chemical coagulation, and ion exchange. *Prep. 1.931, Environmental Analysis II.*
Offered yearly, winter quarter

1.936 Unit Operations in Environmental Engineering II

A continuation of 1.935. Topics include biodegradability studies using the Warburg respirimeter, activated sludge, anaerobic digestion, vacuum filtration, and chemical-physical process involved in wastewater treatment. A comprehensive evaluation of each unit process is required in a report from each student. *Prep. 1.935, Unit Operations in Environmental Engineering I.*
Offered yearly, spring quarter

1.938 Unit Operations in Environmental Engineering (4 q.h. credits)

This course, offered days, embodies the material in 1.935 and 1.936 — Unit Operations in Environmental Engineering. *Prep. 1.933, Environmental Analysis and 1.913, Industrial Waste Disposal.*
Offered yearly, spring quarter

1.940 Public Health Engineering Survey

An historical survey of public health conditions to introduce the student to the modern approach to public health engineering problems. Applications of engineering principles to such problems as garbage and refuse disposal, control of insect-borne diseases, milk and food sanitation, rodent control, camp and recreational sanitation, housing, control of atmospheric pollution, and radiological health. *Prep. Admission to Graduate School of Engineering.*
Offered 1975-76, fall quarter

1.945 Solid Waste Management

Basic solid waste management for engineering and science students covering storage, collection practices, sanitary landfill principles, incineration practices and reclamation possibilities. *Prep. Admission to Graduate School of Engineering.*
Offered yearly, fall quarter

1.946 Waste Reclamation

Review and analyses of various unit operations useful or potentially useful in the separation and processing of salvageable materials from municipal refuse and incinerator residue; economics, management and regulatory practices affecting recovery and recycle possibilities. *Prep. 1.945, Solid Waste Management.*
Offered 1974-75 or by special arrangement, winter quarter

1.947 Incineration

Incinerator design and operation examining the combustion process, design problems and solutions, special incinerators for salvage and industrial operations, performance testing, and pollution control requirements. *Prep. 1.945, Solid Waste Management.*
Offered 1974-75 or by special arrangement, spring quarter

1.948 Solid Waste Laboratory

A laboratory and design course, offered to day students, covering practices related to the physical, chemical, and biological analysis of refuse, residue,

quench waters, and leachate. Field studies involving current local problems. Students will design systems to solve the problems. *Prep. 1.945, Solid Waste Management.* Offered by special arrangement

1.950 Air Pollution Engineering

Theory and practice related to engineering management of air resources; applications of models for the atmospheric dispersion of pollutants; analysis of control systems for gaseous and particulate emissions utilizing dry collection, wet collection, absorption, and catalytic processes. Discussion of source control evaluation and air quality standards. 1.957. *Prep. Admission to Graduate School of Engineering.* Offered yearly, fall quarter

1.951 Radiological Health Engineering

Types and sources of radioactive wastes, methods of handling, storage, and disposition of solid, liquid, and gaseous radioactive wastes. Regulatory agency requirements. *Prep. Admission to Graduate School of Engineering.* Offered 1975-76, winter quarter

1.952 Industrial Hygiene

Characterization and control of industrial problems associated with noise, heat and ventilation. Physical and biological aspects of environmental stress are discussed. Emphasis is placed on the application of engineering principles to the design of control systems. Evaluation procedures for control effectiveness are reviewed. *Prep. Admission to Graduate School of Engineering.* Offered yearly, spring quarter

1.953 Environmental Microbiology

An advanced course in environmental microbiology. Transformations of environmental products containing compounds of sulfur, nitrogen, complex hydrocarbons and pesticides. Advanced techniques for the simulation and evaluation of microbiological systems applied to biological control of water and wastewater. *Prep. 1.922, Environmental Bacteriology.* Offered yearly, spring quarter

1.954 Stream Sanitation

Analysis of the disposal of conservative and non-conservative pollutants in streams. Topics include water quality standards, BOD and oxygen relationships in streams, bacterial pollution, eutrophication, thermal pollution, and general corrective control methods in streams. *Prep. 1.920, Environmental Chemistry I.* Offered yearly, spring quarter, evenings
Offered yearly, fall quarter, days

1.955 Air Sampling and Analysis

A laboratory course on air pollution measurements utilizing physical, chemical, and instrumental methods and calibration and use of sampling equipment for gaseous and particulate pollutants. Identification and quantitative measurements of pollutants are performed utilizing microscopy, spectrophotometry, gas chromatography, and atomic absorption spectroscopy. *Prep. 1.950, Air Pollution.* Offered yearly, spring quarter

1.956 Air Pollution Control (4 q.h. credits)

This course, offered days, embodies the material of 1.950, Air Pollution Engineering and 1.955, Air Sampling and Analysis. *Prep. Admission to Graduate School of Engineering.* Offered yearly, winter quarter

1.957 Air Pollution Science

Biological and chemical aspects of air pollution with emphasis on the toxicological aspects of the environment, physiological effects of aerosols, analysis of organic and inorganic constituents of the atmosphere and rationale for establishment of air quality criteria and standards. Note: Course 1.957 is open to non-engineering graduate students as well as engineering graduate students. *Prep. Consent of the department and instructor.* Offered yearly, winter quarter

1.960 Hydraulic Structures I

Dams and associated structures. Design criteria and preliminary analyses for gravity, arch, buttress, rock-fill and earth-fill dams. Foundation treatment and scour protection. Spillway structures. Gates. Navigation requirements of large rivers. Fishways. *Prep. Undergraduate course in hydraulics.*

Offered yearly, fall quarter

1.961 Hydraulic Structures II

Intake structures in reservoirs and on rivers. Tunnels and pipe lines: design criteria and structural analyses; economic studies for diameter selection. Penstocks and anchor blocks. Canals—seepage and erosion, linings, canal structures. *Prep. Undergraduate course in hydraulics.*

Offered yearly, winter quarter

1.962 Hydraulic Structures III

Surge tanks: selection of type. River regulation: design principles, flood protection and navigation requirements, bank revetments, groins, dikes, and levees. Cofferdams. Operation and maintenance of hydraulic structures. *Prep. Undergraduate course in hydraulics.*

Offered yearly, spring quarter

1.970 Design of Environmental Systems (4 q.h. credits)

The development of comprehensive engineering reports. Fundamental design concepts of complete systems for environmental control, including water treatment; wastewater disposal, air quality control, and solid waste disposal; evaluation of economic alternatives for environmental quality control; discussion of actual engineering reports and designs will include considerations of the logic and conclusions. *Prep. 1.912, Water and Wastewater Treatment III.*

Offered yearly, spring quarter, days

1.980 Environmental Planning and Control

Examination of the social, technological, economic, political, legal and institutional aspects of environmental planning and management; environmental impact and assessment considerations related to development projects; environmental planning methodology and techniques. *Prep. Admission to the Graduate School of Engineering.*

Offered 1974-75, fall quarter

1.985 Environmental Protection

Environmental quality and its effects on health, comfort, aesthetics, balance of ecosystems and renewable resources; interaction of the water-land-air complex, vector control, food protection, ionizing radiation, other radiation, and the energies of heat and sound. *Prep. Admission to the Graduate School of Engineering.*

Offered yearly, winter quarter

1.991 Thesis (Master's Degree) (8 q.h. credits)

Analytical and/or experimental work conducted by arrangement with and under

the supervision of the department. *Prep. Permission of the Civil Engineering Department.* Offered yearly, all quarters

1.992 Special Topics in Environmental Engineering (2 q.h. credits)

An individual effort in an area selected by student and adviser resulting in a definitive report. *Prep. Permission of the Civil Engineering Department.*

Offered yearly, all quarters

1.993 Master's Report Environmental Engineering (4 q.h. credits)

An individual effort consisting of laboratory and/or literature investigation and analysis or advanced design of a project in an area of environmental engineering selected by student and adviser resulting in a definitive report. *Prep. Permission of the Civil Engineering Department.*

Offered yearly, all quarters

1.994 Seminar — Environmental Engineering

Discussions by professional engineers and scientists, faculty, and graduate students on subjects in the area of environmental engineering and science. Open to day students only. *Prep. Consent of the instructor.*

Offered yearly, winter quarter

1.996 Seminar — Environmental Health

Discussion by professional people in the public health field, faculty, and graduate students on subjects within the area of environmental health. Open to day students only. *Prep. Consent of the instructor.*

Offered yearly, spring quarter

1.997 Thesis (Ph.D. Degree)

Open to day students only. *Prep. Admission to doctoral program in Environmental Engineering.*

Offered yearly, all quarters

MECHANICAL ENGINEERING

The courses listed below are of an advanced undergraduate — first year graduate level. A maximum of eight (8) quarter hours of credit from this group of courses may be applied toward the master's degree.

Course	Credits
2.214 Experimental Stress Analysis	4
2.232 Engineering Materials	4
2.233 Thermodynamics of Propulsion	4
2.235 Statistical Thermodynamics	4
2.236 Nuclear Engineering I	4
2.237 Nuclear Engineering II	4
2.258 Gas Dynamics	4
2.260 Heat and Mass Transfer	4
2.270 Dynamics	4
2.817 Strain Gage Techniques	2
2.818 Photoelasticity	2
2.847 Dynamics I	2
2.848 Dynamics II	2

The following undergraduate courses which are given in the daytime, may be elected by graduate students for graduate credit subject to the credit hour restrictions listed above.

2.214 Experimental Stress Analysis (4 q.h. credits)

Embodies the material in 2.817, Strain Gauge Techniques and 2.818, Photoelasticity. *Prep. Admission to the Graduate School of Engineering.*

Offered 1974-75, spring quarter

2.232 Engineering Materials (4 q.h. credits)

Covers thermodynamics of materials; phase equilibria ternary systems; reactions with environment, i.e. kinetics, oxidation, corrosion, etc.; materials design criteria and materials engineering case studies. *Prep. Admission to the Graduate School of Engineering.*

Offered spring quarter

2.233 Thermodynamics of Propulsion (4 q.h. credits)

Application of the physical principles of thermodynamics, fluid mechanics and plasmas to the prediction of the behavior of propulsion devices; airbreathing engines and rocket engines with applications to show how physical laws describe and limit performance of particular devices; introduction to plasmas; fundamentals of electrical rocket engines. *Prep. Admission to the Graduate School of Engineering.*

Offered 1974-75 fall and winter quarters

2.235 Statistical Thermodynamics (4 q.h. credits)

Statistical thermodynamics approaches the study of thermodynamic equilibrium by regarding a system as a collection of particles to which the principles of either classical or quantum mechanics are presumed to apply; the statistical hypotheses of Boltzmann, Bose-Einstein, and Fermi-Dirac with emphasis on the properties of assemblies of independent particles; applications will be made to the study of gaseous systems, the Einstein and Debye theories of the specific heats of solids and the electron gas in a metal. *Prep. Admission to the Graduate School of Engineering.*

Offered 1974-75, spring quarter

2.236 Nuclear Engineering I (4 q.h. credits)

Study of Nuclear Physics emphasizing atomic and nuclear structure, radioactive decay, and nuclear reactions with particular attention to fusion and fission; health physics, nuclear instrumentation, and the production and uses of radioactive isotopes; comparison of thermal, fast, and breeder reactor types; discussion of neutron interactions and slowing down; four-factor formula and the diffusion equation developed and applied to one-group theory for bare and reflected thermal reactors; energy production and distribution within the core; flux shaping. Not open to students who have completed 2.942, 2.943, and 2.944. *Prep. Admission to the Graduate School of Engineering.*

Offered fall and winter quarters

2.237 Nuclear Engineering II (4 q.h. credits)

Development of two-group theory for thermal reactors; the physics and safety of fast reactors; effect of reactivity change, either intentional or accidental, changes due to temperature; fission product buildup, xenon buildup after shutdown, and fuel depletion; reactor design considerations including the interrelationship of reactor physics, reactor engineering (physical design heat transfer, etc.), reactor materials and economics; control and distribution of power; fuel cycle management. Not offered to students who have completed 2.942, 2.943, and 2.944. *Prep. Admission to the Graduate School of Engineering.*

Offered spring quarter

2.258 Gas Dynamics

This course continues the study of fluid mechanics with emphasis on compressibility phenomena. The concept of sound speed is introduced and attention is devoted to one-dimensional steady flows. The effects of area change, friction, and heat transfer are considered, including the study of normal shock waves and the behavior of nozzles and diffusers. *Prep. Admission to the Graduate School of Engineering.* Offered 1975-76, spring quarter

2.260 Heat and Mass Transfer (4 q.h. credits)

Review of heat, mass, and momentum transfer analogies; rate equations; conduction problems in steady-state and transient-state for both heat and mass transfer with various constant and fluctuating boundary conditions in rectangular, cylindrical, and spherical coordinates solved by formal mathematics, difference (relaxation) techniques and methods of analogy; thermal stresses induced by non-uniform temperature distributions; heat transfer at high velocity and in rarefied gases; boiling heat transfer at temperature extremes, with forced and natural convection; phase change in bulk stagnant systems. *Prep. Admission to the Graduate School of Engineering.* Offered fall and winter quarters

2.270 Dynamics (4 q.h. credits)

Embodies the material in 2.847 and 2.848 — Dynamics I and II. *Prep. Admission to the Graduate School of Engineering.* Offered summer quarter

The following are graduate courses which carry two quarter hours of credit unless otherwise noted. Courses carrying four quarter hours of credit are day courses. Seminar and thesis may have varying credits established by the department at the time of registration. Not all courses are offered every year. Refer to the Graduate School of Engineering circular issued about July 1 each year for the courses to be offered in the new academic year and the times at which they are scheduled to meet.

2.804 Theory of Elasticity

Algebra and Calculus of Cartesian tensors relation to vector analysis; stress in a continuum, strain and strain rate in a continuum; governing equations for an elastic solid. *Prep. Admission to the Graduate School of Engineering.*

Offered fall quarter

2.805 Theory of Elasticity

Stress and deformation analysis of elastic solids. Two-dimensional problems; stress concentration; thermal stress. Theory of torsion, prismatic and axial symmetric bars. Introduction to the theory of plates, bending of thin plates. *Prep. 2.802, Continuum Mechanics or 2.804, Theory of Elasticity.* Offered winter quarter

2.806 Theory of Elasticity

Method of finite differences. Numerical solutions; torsion problem; plate bending. Variational method and energy principles; minimum potential and complementary energy theorems. Introduction to dynamics of elastic solids; waves, vibrations. *Prep. 2.805, Theory of Elasticity.* Offered spring quarter

2.809 Plasticity and Creep

Types of deformation, elasticity, plasticity, creep, mechanical equation of state, plastic flow under multi-axial stress, and elastic creep. Relationship of com-

paratively simple laboratory material tests to more complex service conditions will be emphasized. *Prep. A recent introductory materials course.*

Offered 1974-75, spring quarter

2.810 Advanced Mechanics of Materials I

Review of fundamental stress concepts; point stress and strain; differential equations of stress; elastic properties; theories of failure; transverse bending; shear stress distribution; shear center; bending stresses due to non-symmetrical bending. *Prep. Admission to the Graduate School of Engineering.*

Offered fall quarter

2.811 Advanced Mechanics of Materials II

Thick and thin cylinders under elastic and plastic deformation; analysis of statistically indeterminate beams and frames by slope, deflection, and moment distribution techniques; stresses in curved beams, beams on elastic foundations.

Prep. 2.810, Advanced Mechanics of Materials I.

Offered winter quarter

2.813 Advanced Mechanics of Materials III

Bending of flat plates; stability analysis of structural members; grid systems and other special topics to be selected by needs of the class. *Prep. 2.811, Advanced Mechanics of Materials II.*

Offered 1975-76, spring quarter

2.815 Plates and Shells

Bending of plates with various shapes, loads, and supports. Large deflection of plates. Membrane theory of shells. Analysis of cylindrical shells. General theory of thin elastic shells. Shells of revolution. *Prep. 2.806, Theory of Elasticity.*

Offered 1974-75, spring quarter

2.817 Strain Gauge Techniques

Theory and application of mechanical and electrical strain gauges. Installation, instrumentation, and circuitry of gauge set-ups for transducer use and experimental stress analysis. Use of brittle coatings in experimental stress analysis. *Prep. Admission to Graduate School of Engineering. See course 2.214.*

Not offered 1974-76

2.818 Photoelasticity

Theory and practice of photoelastic methods as applied to classical experimental stress analysis of models and as modified for use in photoelastic coatings. *Prep. Admission to Graduate School of Engineering. See course 2.214.*

Not offered 1974-76

2.819 Fluid Dynamics I

Discussion of a number of kinematic concepts important in the area of fluid dynamics; deformation rate, vorticity, the equation of continuity; a description of the state of stress in a fluid; derivation of the Navier-Stokes equation and the energy equation; appropriate boundary conditions will be considered; some study of surface-tension phenomena. *Prep. Admission to the Graduate School of Engineering.*

Offered fall quarter

2.820 Fluid Dynamics II

Study of viscous fluids of uniform, constant density; exact solutions of the governing equations; a study of two classes of flow, each of which is well-described by an approximate theory: the first is Stokes, or creeping flow, the relevant approximations being suitable for low Reynolds number, the second approximation is that formulated in boundary layer theory and valid at high

Reynolds number. In connection with the latter, suitable computation schemes for two-dimensional, steady, laminar boundary layers are presented. *Prep. 2.819, Fluid Dynamics I.* Offered winter quarter

2.821 Fluid Dynamics III

Emphasis on the study of flows in which viscosity may be neglected as a suitable approximation; two-dimensional potential flows using the theory of complex variables; streaming flows past cylinders and airfoils; other topics include: the irrotational flow due to a waving rigid body, wave propagation at an interface, and inviscid fluid motions possessing vorticity. *Prep. 2.820, Fluid Dynamics II.* Offered spring quarter

2.823 Advanced Gas Dynamics

The consequences of fluid compressibility are studied. Shock waves and the theory of characteristics are discussed with specific consideration given to two-dimensional steady flows and one-dimensional unsteady flows. *Prep. 2.820 Fluid Dynamics.* Offered 1975-76, fall quarter

2.824 Advanced Gas Dynamics

This course continues the subject matter of 2.823. Additional topics may include axially-symmetric steady flow, small-perturbation theory, similarity rules, the hodograph method, or some aspects of physical acoustics. *Prep. 2.823 Advanced Gas Dynamics.* Offered 1975-76, winter quarter

2.826 Math. Methods for Mechanical Engineers I

Bessel and Legendre functions; boundary-value problems and series of orthogonal functions. Partial differential equations and applications to heat transfer fluid flow, vibrations and wave propagation. *Prep. Admission to Graduate School of Engineering.* Offered fall & winter quarters

2.827 Math. Methods for Mechanical Engineers II

Functions of a complex variable; Laurent series and singularities; residues and contour integration; conformal mapping and application; introduction to complex transforms. *Prep. Admission to Graduate School of Engineering.* Offered fall, winter, spring quarters

2.828 Math. Methods for Mechanical Engineers III (Prerequisite: 2.826, 2.827)

Topics selected from various areas of engineering analysis; analytic approximation techniques; asymptotic and singular perturbation methods; integral transforms; variational formulations. Offered 1974-75, spring quarter

2.838 Engineering Fracture Mechanics I

Fundamentals of brittle fracture; theoretical strength, micro/macro fracture characteristic, Inglis-Griffith theory, applicability of same. Linear elastic fracture mechanics; Orowan/Irwin extension to metals, effective surface tension and relation to fracture toughness, plastic zone size correction; geometry effects on fracture toughness; plane strain/plane stress fracture toughness, thickness effects. *Prep. Admission to the Graduate School of Engineering.* Offered fall quarter

2.839 Engineering Fracture Mechanics II

Experimental determination of fracture toughness; slow crack growth "pop-in", arrest, R-G curves, compliance techniques for determining elastic energy

release note. Alternate fracture toughness concepts; resistance curve, crack opening displacement, the J integral. Application of fracture mechanics to fatigue. Design methods to minimize risks of catastrophic failure will be emphasized. *Prep. 2.838, Engineering Fracture Mechanics I.* Offered winter quarter

2.840 Finite Element Analysis Methods

Introduction to the finite element method of numerical analysis; applications in solid mechanics include direct methods, energy approaches and weighted residuals; formulation of simple element stiffness matrices and assembly in one and two dimensions; solids of revolution; brief discussion of complex elements used in large computer programs. Various examples of existing programs to be taken from statics, dynamics, plasticity and heat transfer. *Prep. 2.802, Continuum Mechanics or permission of instructor.* Offered spring quarter

2.841 Vibration Theory and Applications

Modeling of vibratory systems; one degree of freedom systems (determination of equations of motion using free-body and energy methods); forced and free vibrations through two degrees of freedom; Laplace transformation techniques; phase-plane diagrams for undamped forced vibrations and Coulomb damping. *Prep. Admission to the Graduate School of Engineering.* Offered fall quarter

2.842 Vibration Theory and Applications

Multiple degrees of freedom; free and forced vibrations with or without damping, extensional and torsional oscillation, frequency equation, energy methods of solution. *Prep. 2.841, Vibration Theory and Applications or 2.861, Systems Engineering.* Offered winter quarter

2.843 Vibration Theory and Applications

Systems with distributed mass and stiffness; shock and impact; vibrations of beams and related structures; nonlinear and random vibrations. *Prep. 2.842, Vibration Theory and Applications.* Offered spring quarter

2.845 Shock, Vibration, and Noise Control

Theoretical and practical considerations pertinent to the design and protection of structures and equipment subject to severe environments of transient shock, steady state vibration, random vibration, and acoustic noise. *Prep. 2.843, Vibration Theory and Applications.* Offered 1975-76, spring quarter

2.846 Non-Linear Vibrations

Studies of various non-linear problems and the techniques used in solving them. Symmetrical and unsymmetrical systems. The Van der Pol-Kryloff-Bogoliuboff method as well as others will be discussed. *Prep. 2.843, Vibration Theory and Applications.* Offered 1974-75, spring quarter

2.847 Dynamics I

Application of fundamental laws of motion. Transformations of coordinate systems, kinematics of a particle using translating or rotating axis, LaGrange equations, space dynamics. *Prep. Admission to the Graduate School of Engineering.* See course 2.270. Not offered 74-75, 75-76

2.848 Dynamics II

Dynamics of rigid bodies, moments of inertia in three dimensions, Euler's Equations, includes gyroscopic motion. *Prep. 2.847 Dynamics I.* See course 2.270. Not offered 74-75, 75-76

2.849 Automatic Control Engineering

Concepts of feedback control; formulation of equations, transfer functions, and block diagrams representing components and systems; linearization; Laplace transformation; stability. *Prep. Admission to the Graduate School of Engineering.* Offered fall quarter

2.850 Automatic Control Engineering

Study of control action; analysis and design by use of root-locus and frequency-domain techniques. *Prep. 2.849, Automatic Control Engineering.*

Offered winter quarter

2.851 Automatic Control Engineering

Further consideration of linear systems including compensation methods and multiple-inputs. Techniques for the treatment of non-linear systems. *Prep. 2.850, Automatic Control Engineering.* Offered spring quarter

2.853 Fundamentals of Instrumentation

Theoretical principles underlying the design and operation of instruments for measurement and/or control. Analysis of stimulus-response relations. Industrial instruments for measurement and control, including those based on pneumatic and electrical systems. *Prep. Bachelor of Science degree.* Offered fall quarter

2.854 Industrial Process Control

Fundamental principles involved in automatic control of industrial processes. Economic considerations. Application of control instruments to obtain automatic control of temperature, pressure, fluid flow, liquid level, humidity, pH. *Prep. 2.853, Fundamentals of Instrumentation.* Offered winter quarter

2.870 Ocean Engineering I

Extent of the ocean in general with its physical and chemical properties; emphasis on the three-dimensional temperature distribution with time as a variable; the salinity and its variation in oceanic space and time; the density of the ocean and its stability; temperature-salinity relationships and their connection with mixing processes with large water masses; evaporation and water budget of the earth, and ice in the ocean. *Prep. Admission to the Graduate School of Engineering.* Offered fall quarter

2.871 Ocean Engineering II

Geophysical structure of the sea; forces and their relation to the structure of the ocean; ocean statics, oceanic kinematics; theory of ocean currents in a homogeneous and non-homogeneous ocean; strait currents; effect of wind; the mass field and density current; fundamental principles of oceanic circulation in the troposphere and stratosphere. *Prep. 2.870, Ocean Engineering I.*

Offered winter quarter

2.873 Geophysical Engineering

Theory of basic geophysical methods, seismology, magnetics, gravity, and electromagnetic potential relating to ocean research and exploration with emphasis on theory, data processing, computer applications; interpretation of data and their applications; instrument systems; survey procedures; profiling; surface ship systems applications and deep submersible applications. *Prep. Admission to the Graduate School of Engineering.* Offered fall quarter

2.874 Ocean Measurements

Instrument design; theory application for physical and chemical properties;

bathymetry; temperature, velocity and geophysical aspects of seismic, gravity, magnetic, and electromagnetic methods. *Prep. 2.873, Geophysical Engineering.*

Offered winter quarter

2.901 Advanced Thermodynamics

A critical examination of equilibrium thermodynamics from a rigorous viewpoint emphasizing fundamental concepts including: equilibrium, heat, and work; the first and second law of thermodynamics; energy; heat engines, simple systems, and open systems. *Prep. Admission to the Graduate School of Engineering.*

Offered fall quarter

2.902 Advanced Thermodynamics

Continuation of 2.901 including: examination of temperature scales; entropy and availability; the phase rule, single component systems; thermodynamic relations. Consideration is also given to the ideal gas; chemical potential and thermodynamics of ideal gas mixtures. *Prep. 2.901, Advanced Thermodynamics.*

Offered winter quarter

2.903 Advanced Thermodynamics

Embodies the material in 2.901 and 2.902 Advanced Thermodynamics. *Prep. Admission to the Graduate School of Engineering.*

Offered winter quarter

2.904 Special Topics in Advanced Thermodynamics

Selected subjects of current interest in general thermodynamics including: chemical reactions; the law of stable equilibrium, normal and special systems, and the third law. Detailed analysis of the statistics of ensembles is also covered to emphasize the relationship between thermodynamics and statistical mechanics. *Prep. 2.902, Advanced Thermodynamics.*

Offered spring quarter

2.905 Cryogenic Engineering

Designed to provide a familiarity with the general field of cryogenics, some of the principal uses of cryogenics, and the ways of obtaining and preserving an environment at a low temperature. Refrigeration, cycle analysis, heat exchanger design, insulation systems, properties of materials, instrumentation problems and applications. Problems will be assigned typical of those which are encountered in the field and laboratory. *Prep. Admission to the Graduate School of Engineering.*

Offered fall quarter

2.906 Cryogenic Engineering

Continuation of 2.905, Cryogenic Engineering. *Prep. 2.905, Cryogenic Engineering.*

Offered winter quarter

2.907 Cryogenic Engineering

Application of Cryogenic Engineering Principles to the design of integrated systems. *Prep. 2.906, Cryogenic Engineering.*

Offered spring quarter

2.910 Conduction Heat Transfer

Basic laws of heat transfer; analytical solutions of single and multidimensional systems in steady and transient states with and without heat sources in cartesian, cylindrical, and spherical coordinates; chart solutions; Newtonian method, steady state and transient numerical analysis; generalized fin equation. *Prep. Elements of Heat Transfer.*

Offered fall quarter

2.911 Convection Heat Transfer

Fundamentals of convection; Reynolds, Prandtl, and Nusselt numbers; elements

of boundary layer theory; free and forced convection in ducts and over flat plates solved by dimensional, exact mathematical and approximate integral analyses for both laminar and turbulent flows; Reynolds analogy and Prandtl's modification; boiling and condensation; heat transfer in high speed flow; heat exchangers. *Prep. Elements of Heat Transfer.* Offered winter quarter

2.913 Radiation Heat Transfer

Basic laws of thermal radiation; Planck black body radiation; Kirchhoff's laws; Stefan-Boltzmann law; radiation properties of surfaces; radiative transfer between gray and non-gray diffuse and specular surfaces separated by transparent media; radiation properties of gases; radiative transfer through absorbing, emitting, and scattering media; radiative transfer in the presence of conduction and convective heat transfer. *Prep. Elements of Heat Transfer.*

Offered spring quarter

2.920 Direct Energy Conversion

The fundamental processes of direct energy conversion and their application to the design and operation of magnetohydrodynamic power generators, thermionic converters, fuel cells, and thermoelectric converters. *Prep. Admission to the Graduate School of Engineering.*

Offered 1974-75, fall quarter

2.921 Direct Energy Conversion

Continuation of 2.920. *Prep. 2.920, Direct Energy Conversion.*

Offered 1974-75, winter quarter

2.923 Special Topics in Direct Energy Conversion

Irreversible thermodynamics. Unified theory of energy conversion. *Prep. 2.921, Direct Energy Conversion.*

Offered 1974-75, spring quarter

2.930 Pumps

Deals mainly with centrifugal pumps, with brief references to other types; flow of fluids in pipes and conduits, system curves, pump head velocity diagrams and head development, efficiency; specific speed, net positive suction head, cavitation; affinity laws, selection of pumps to suit various operating conditions and methods of driving, parallel operation; automatic operation, types of construction and materials used, methods of priming centrifugal pumps, pumping of chemicals, oils, and sludges, special problems of pump installation and operation, water hammer in pump discharge lines. *Prep. Hydraulics.*

Offered 1974-75, spring quarter

2.931 Fans and Blowers

Flow of air in pipes and ducts, fan characteristics and laws, various types of fan wheels, inlet and outlet connections, fan capacity control, fan selection and testing. Compression of air and gases, flow in pipes, head-on blowers, performance curves, effect of changes in speed and inlet conditions, construction, regulation, selection, installation, and testing. Axial flow fans and blowers. Positive pressure blowers. *Prep. Thermodynamics.*

Offered 1975-76, spring quarter

2.932 Pollution Problems from Combustion Processes I

A major portion of the energy produced in the United States depends upon combustion processes including energy produced in electrical power generation, motor vehicles, and aircraft. Combustion processes have contributed to air, water, and noise pollution problems. This course examines combustion sys-

tems in detail to determine sources of pollution problems and to designate methods by which these problems can be met.

An overview of the energy production by electrical power generation systems, motor vehicles, and aircraft so that the magnitude of the contribution of these systems to the pollution problem can be assessed. These systems will be described as heat engines. A thermodynamic analysis will be made to evaluate their efficiencies. The correlation between heat engine efficiency and its effect on pollution problems will be discussed. *Prep. Admission to the Graduate School of Engineering.* Offered 1975-76, fall quarter

2.933 Pollution Problems from Combustion Processes II

Basic principles of combustion processes are developed for an understanding of the emission products as a function of system operating conditions. Topics of thermochemistry, chemical equilibrium, chemical kinetics, conservation of energy, equation of motion, chemistry of hydrocarbons, and theories of combustion processes are presented toward this end. *Prep. 2.932, Pollution Problems from Combustion Processes I.* Offered 1975-76, winter quarter

2.934 Pollution Problems from Combustion Processes III

Combustion systems include physical processes as well as chemical. Physical processes of fuel injection, atomization, vaporization, and mixing, and their relation to combustion systems, will be discussed. Details of operation of electrical power generation systems, automotive engines, and aircraft engines are examined to identify sources of pollution and designate methods for pollution control. *Prep. 2.933, Pollution Problems from Combustion Processes II.*

Offered 1975-76, spring quarter

2.935 Power Plant Design

Study of the thermodynamic cycles, equipment, and processes of the various types of power plants, with emphasis on modern central station practice. *Prep. Thermodynamics.* Offered fall quarter

2.936 Power Plant Design

Continuation of 2.935, Power Plant Design. *Prep. 2.935.* Offered winter quarter

2.938 Power Generation Economics

Integrated study of the various factors affecting cost of power generation, including the effects of fuels availability and pricing, equipment selection and plant efficiency, siting and financial considerations. *Prep. 2.935.*

Offered spring quarter

2.942 Nuclear Engineering I

Topics include: growth of nuclear power industry; study of nuclear physics emphasizing atomic and nuclear structure, radioactive decay, and nuclear reactions with particular attention to fission and fusion; radiation health physics; principles of shielding; nuclear instrumentation; production and application of radioisotopes; neutron interactions and slowing down theory; neutron activation analysis. (Not open to students who have completed 2.236 & 2.237.) *Prep. Admission to Graduate School of Engineering.* Offered fall quarter

2.943 Nuclear Engineering II

Comparison of thermal, fast, and breeder reactors; four factor formula and the neutron diffusion equation; one-group, modified one-group, two-group and multi-

group theory; bare and reflected thermal reactors; energy production and distribution within core; flux shaping; transient reactor behavior and control; factors affecting reactivity including temperature, pressure, void formation, fission product accumulation, fuel depletion and fuel breeding; Xenon buildup after shutdown. (Not open to students who have completed 2.236 & 2.237.) *Prep. 2.942.* Offered winter quarters

2.944 Nuclear Engineering III

Reactor design considerations; interrelationship of reactor physics, control, engineering, materials, safety, and fuel cycle management; reactor types; radiation damage and reactor materials; nuclear fuels; reactor heat transfer; economics of nuclear power; environmental effects. (Not open to students who have completed 2.236 & 2.237.) *Prep. 2.943.* Offered spring quarters

2.953 Advanced Physical Metallurgy III

Point defects in crystals; theory of diffusion in solids, including diffusion equations, mechanisms, effect of concentration gradients, diffusion in non-metallic solids; oxidation. *Prep. A recent introductory material science course.* Offered 1974-75, spring quarter

2.954 Advanced Physical Metallurgy I

Dislocation theory; including such topics as dislocation stress fields, self energy, velocity, interactions mechanisms, image forces, and theories of yielding. *Prep. A recent introductory material science course.* Offered 1974-75, fall quarter

2.956 Advanced Physical Metallurgy II

Mechanical behavior of metals. Application of dislocation theory to microplasticity, strain hardening, strengthening mechanisms and creep. *Prep. 2.954, Advanced Physical Metallurgy I.* Offered 1974-75, winter quarter

2.960 Thermodynamics of Materials I

Basic metallurgical thermodynamics encompassing first, second, and third laws, entropy, enthalpy, and free energy. *Prep. Engineering Materials.* Offered 1975-76, fall quarter

2.961 Thermodynamics of Materials II

Continuation of 2.960 with emphasis on solutions, activity, activity coefficients, the phase rule and applications to some metallurgical problems. *Prep. 2.960, Thermodynamics of Materials I.* Offered 1975-76, winter quarter

2.963 Thermodynamics of Materials III

The application of metallurgical thermodynamics to various process metallurgical problems, i.e., gas-solid systems, etc., plus kinetics of reactions and dynamics systems analysis. *Prep. 2.960 or 2.961, Thermodynamics of Materials I or II.* Offered 1975-76, spring quarter

2.965 Physical Ceramics

Introduction to ceramic fabrication processes. Characteristic of vitreous and crystalline solids, structural imperfections, and atomic mobility. Phase equilibria, nucleation, crystal growth, solid-state reactions, non-equilibrium phases, and effects on the resulting microstructure of ceramics. *Prep. A recent introductory material science course, Physical Chemistry or Solid State Physics.* Offered 1974-75, fall quarter

2.966 Physical Ceramics

Discussion of effects of composition and microstructure on the thermal, mechanical, optical, electrical, and magnetic properties of ceramic materials. *Prep.* 2.965, *Physical Ceramics*. Offered 1974-75

2.970 Material Science and Engineering

Principles underlying the structure and properties of solid materials. The relationships of these principles to the properties and to applications in structures and devices. Both macroscopic-phenomenological and electronic-molecular approaches will be used. Materials will include metals and alloys, semiconductors, and dielectrics. Typical subjects are atomic and electronic structures, ordering, nucleation, crystal growth, and thermal properties. *Prep.* A recent introductory material science course. Offered 1975-76, fall quarter

2.971 Material Science and Engineering

Continuation of 2.970 into additional topics such as thermal, electric, magnetic, and optical properties; applications of solid-state phenomena to achieve functions embodied in transducers, filters, amplifiers, energy converters, and so forth. *Prep.* 2.970, *Material Science and Engineering*.

Offered 1975-76, winter quarter

2.972 Materials Science and Engineering III

Continuation of 2.971 plus a discussion of various special topics that will vary from year to year. Examples are: metastable phases and thin films. *Prep.* 2.971, *Materials Science and Engineering II*. Offered 1975-76, spring quarter

2.975 Principles of X-Ray Diffraction

General properties of x-rays. X-Ray production and detection. Emission and absorption. Introduction to diffraction and factors influencing the intensities. Analysis of diffraction patterns. *Prep.* A recent introductory material science course. Offered 1975-76, fall quarter

2.976 Applications of X-Ray Diffraction

Experimental methods. Applications, including: single crystal orientation, crystallite size measurement, preferred orientation, residual stresses, precision lattice-parameter measurement, phase-diagram determination, chemical analysis. *Prep.* 2.975, *Principles of X-Ray Diffraction*. Offered 1975-76, winter quarter

2.983 Metallurgical Systems for Structural Applications

Several important metallurgical systems are studied with emphasis on categorizing their utility and explaining sources of their strength, fracture toughness and creep resistance. Materials considered include: high strength steels, maraging alloys, aluminum and titanium alloys, ceramics and metals for high temperature applications, metal matrix and resin matrix fibre composite materials. *Prep.* An undergraduate materials science or metallurgy course.

Offered 1975-76, spring quarter

2.985 Powder Metallurgy

Powder characteristics and methods of manufacture. Powder pressing: packing, interparticle bonding, effects of pressure. Principles of sintering. Characteristics and properties of products made from powdered materials. *Prep.* A recent introductory material science course. Offered 1974-75, spring quarter

2.986 Behavior of Materials Under High Pressures I

Historical development of high pressure research in brief. Basic design principles of static high pressure apparatus; use of gases, liquids and solids as pressure transmitting media; introduction to principles of shock wave method; equations of state of solids and their measurement at high pressures and at ultra high pressures. *Prep. Admission to the Graduate School of Engineering.*

Offered 1974-75, fall quarter

2.987 Behavior of Materials Under High Pressures II

Crystal structure transformation, electronic transitions and insulator-metal transitions under pressure; electrical and magnetic properties and deformations of solids under pressure; geological phenomena related to high pressures; current developments in high pressures. *Prep. 2.986, Behavior of Materials Under High Pressure I.*

Offered 1974-75, winter quarter

2.990 Mechanical Engineering Seminar

Discussions by industrial leaders, faculty, and graduate students on various subjects. Open to day students only. *Prep. Admission to Master of Science program.*

Offered yearly, fall and winter quarters

2.991 Thesis (Master's Degree)

Analytical and/or experimental work conducted under the auspices of the department. Open to day students only. *Prep. Admission to Master of Science program.*

Offered yearly, all quarters

2.992 Special Problems in Mechanical Engineering

Theoretical or experimental work under individual faculty supervision. *Prep. Consent of department chairman.*

Offered yearly, all quarters

2.993 Special Topics in Mechanical Engineering

Topics of interest to the staff member conducting this class are presented for advanced study. *Prep. Permission of department staff.*

Offered yearly, all quarters

2.994 Doctoral Reading

Material approved by the candidate's adviser (only S or F grades will be assigned for this course). *Prep. Passing of Ph.D. Qualifying Exam.*

Offered yearly, all quarters

2.995 Thesis (Ph.D. Degree)

Theoretical and experimental work conducted under the supervision of the department. Open to day students only. *Prep. Admission to the Doctoral Program in Mechanical Engineering.*

Offered yearly, all quarters

2.996 Thesis (Mechanical Engineer Degree)

Analytical and/or experimental work conducted under the auspices of the department. Open to day students only. *Prep. Admission to the Mechanical Engineer Degree Program.*

Offered yearly, all quarters

ELECTRICAL ENGINEERING

3.800 Plasma Engineering I

Behavior, diagnostics, and generation of plasma and gas discharges; emphasis on the engineering and experimental point of view rather than on a rigorous theoretical treatment. Current literature on a variety of plasma engineering applications will be introduced throughout the course. First quarter topics include: dynamics of charged particles in static electric and magnetic fields, E and M wave-plasma interactions, Infinite and Finite Media, elastic and inelastic collisions. *Prep. Bachelor of Science degree in Electrical Engineering or Physics or 3.977, Precis of Modern Electrical Engineering III.* Fall quarter

3.801 Plasma Engineering II

Ionization, diffusion, sheaths, glow and arc discharges, plasma oscillations, and plasma diagnostic techniques. *Prep. 3.800, Plasma Engineering I.* Winter quarter

3.802 Plasma Engineering III

Principles of MHD and Controlled Fusion Engineering. General plasma engineering applications. *Prep. 3.801, Plasma Engineering II.* Spring quarter

3.803 Plasma Engineering (4 q.h. credits)

Offered days. Includes the material given in 3.800 and 3.801 — Plasma Engineering I and II. *Prep. Bachelor of Science degree in Electrical Engineering or Physics or 3.977, Precis of Modern Electrical Engineering III.* Winter quarter

3.806 Lasers I

Review of basic optical principles and atomic physics; introduction to optical coherence; models for the interaction of electromagnetic radiation with matter; a general description of lasers is given. *Prep. Bachelor of Science degree in Engineering or Science.* Fall quarter

3.807 Lasers II

Laser threshold and rate equations; elementary resonator theory and fabrication; giant pulse operation; specific solid-state, liquid, and gas lasers; and laser systems. *Prep. 3.806, Lasers I.* Winter quarter

3.810 Thermonuclear Fusion Energetics I

Thermonuclear fusion as an ultimate energy source. Generation of thermonuclear plasmas in confinement devices. Principles of laser-induced fusion. Thermonuclear reactor design. Problems in the magnetic confinement of thermonuclear plasmas. *Prep. Bachelor of Science degree in engineering or science.* Fall quarter

3.811 Thermonuclear Fusion Energetics II

Streaming instabilities and parametric complication in plasmas. Generation of thermonuclear plasmas from relativistic beams. Shock waves in thermonuclear plasmas. *Prep. 3.810 Thermonuclear Fusion Energetics I.* Winter quarter

3.812 Thermonuclear Fusion Energetics III

Plasma electrodynamics. Power gain of charged particles in thermonuclear plasma-radiation systems. Theory of Landau damping and micro-instabilities in collisionless plasmas. *Prep. 3.811 Thermonuclear Fusion Energetics II.* Spring quarter

3.817 Physical Acoustics

Radiation, transmission, and absorption phenomena of plane and spherical waves. Distributed-system analogies, simple sources, dipole sources, radiation impedance, and radiation patterns. Diffraction theory and ray acoustics. Finite amplitude waves and shock waves. The effects of inhomogeneities and of dissipation processes on sound transmission. *Prep. Bachelor of Science degree in Engineering or Science.* Fall quarter

3.818 Speech Communications

Theory of acoustic transducers, such as microphones, loudspeakers, and horns. Mechanism of speech production and the acoustic properties of the vocal system. Hearing and psychoacoustics, Analog synthesizers of speech. Speech coding and transmission systems. *Prep. 3.817 Physical Acoustics.* Winter quarter

3.819 Underwater Sound

Fundamentals of sonar and acoustic signal processing. Echo ranging and direct listening. Model of the underwater acoustic channel. Matched filters and correlation detection. *Prep. 3.818, Speech Communications.* Spring Quarter

3.823 Mathematical Methods in Electrical Engineering (4 q.h. credits)

This course, offered days, embodies the material in 3.8C4 and 3.8C5, Mathematical Methods in Electrical Engineering II-A and II-B. (Not open to Northeastern graduates who have completed 3.293). *Prep. Bachelor of Science degree in Engineering.* Fall and winter quarters

3.824 Linear Systems Analysis I (Fundamental Precepts)

A study of the basic concepts of time and frequency domain analysis including differential equations and systems of simultaneous first order equations, integral solutions including superposition and convolution integrals and Green's function solutions; the application of complex variable theory to the study of Laplace and z-transforms; the application of matrix theory to systems analysis. *Prep. Bachelor of Science degree in Electrical Engineering or 3.975, Precis of Modern Electrical Engineering I. Recommended are courses 3.8C4 and 3.8C5 or their equivalent.* Fall, winter, and spring quarters

3.825 Linear Systems Analysis II-A (State Variable Representation of Systems)

A continuation of program begun with 3.824. Introduction to state variable analysis of continuous and discrete systems. Standard canonical representations. Computer simulation of systems behavior. Solution of state equations for linear time invariant systems. Analysis of transient response. *Prep. 3.824, Linear Systems Analysis I or equivalent.* Fall, winter, and spring quarters

3.826 Linear Systems Analysis II-B (Applications of State Variable and Transform Techniques)

A continuation of 3.825. Extensions of techniques to time varying systems. Stability and related matters. Introduction to optimization and optimal systems. Observability and controllability. Further applications to discrete as well as continuous systems. The application of digital computers to systems analysis. *Prep. 3.825, Linear Systems Analysis II-A.* Winter and spring quarters

3.827 Linear Systems Analysis through State Variable and Transform Techniques (4 q.h. credits)

Offered days. Includes the material given in 3.825 and 3.826, Linear Systems

Analysis II-A and II-B. *Prep. Bachelor of Science degree in Electrical Engineering and 3.824, Linear Systems Analysis I or equivalent.*

Fall and winter quarters

3.830 Network Synthesis I-A

Matrix circuit analysis including m-port parameter systems. Positive-real functions. Energy functions. Driving-point synthesis techniques for LC, RC, and RL networks. *Prep. Bachelor of Science degree in Electrical Engineering or 3.975, Precis of Modern Electrical Engineering I.* Fall, winter, and spring quarters

3.831 Network Synthesis I-B

Driving-point synthesis of RLC networks. Properties of two-port networks. Two-port synthesis, including the parallel ladder realization. Lattice synthesis. *Prep. 3.830, Network Synthesis I-A.* Fall, winter, and spring quarters

3.832 Network Synthesis I (4 q.h. credits)

Offered days. Includes the material given in 3.830, Network Synthesis I-A and 3.831, Network Synthesis I-B. *Prep. Bachelor of Science degree in Electrical Engineering or 3.975, Precis of Modern Electrical Engineering I.*

Fall and spring quarters

3.833 Network Synthesis II

Scattering, immittance, and hybrid formalisms for linear networks; state-space formulation and techniques for time-invariant and time-varying networks; introduction to passive n-port synthesis. *Prep. 3.831, Network Synthesis I-B or 3.832, Network Synthesis I.* Fall quarter

3.834 Advanced Network Theory I

General realizability of linear lumped and distributed systems; synthesis of reciprocal and non-reciprocal n-port networks; lossless microwave multi-port junctions; stability characterizations of active networks; theory of linear active multi-port networks. *Prep. 3.833, Network Synthesis II.* Winter quarter

3.835 Advanced Network Theory II

Interrelationship between parts of network functions; theory of optimum broadband matching; approximation methods and insertion loss synthesis; analysis and synthesis of transmission line filters and equalizers; gain-bandwidth theory of negative resistance devices including tunnel diodes, varactors, avalanche transit-time, and bulk-effect devices. *Prep. 3.834, Advanced Network Theory I.* Spring quarter

3.837 Introduction to Graph Theory

Fundamentals of graph theory, including blocks, trees, connectivity, partitions, traversability, line graphs, factorization, coverings, planarity, matrices, digraphs, and enumeration problems. Selected applications of graph theory in such fields as network theory, switching theory, and computer science. *Prep. Bachelor of Science degree in Engineering or Science.* Fall quarter

3.838 Nonlinear Circuit Analysis I

Numerical, graphical, and analytical methods for the solution of physical systems described by nonlinear differential equations. Geometric analysis in second-order systems. Perturbation and averaging theory. *Prep. 3.831, Network Synthesis I-B or 3.832, Network Synthesis I.* Winter quarter

3.839 Nonlinear Circuit Analysis II

Linear, time-varying systems and their relationship to certain nonlinear problems. The WKB approximation. The Hill and Mathieu Equations. Stability of nonlinear systems. Lyapunov Theory. Selected topics in nonlinear analysis according to group interest. *Prep. 3.838, Nonlinear Circuit Analysis I.* Spring quarter

3.840 Linear Active Circuits I-A

Active networks are developed from device representation and appropriate circuit theory concepts. Topics included are application of flowgraphs and matrices to design and analysis, development of solid state device models, stability, integrated circuitry limitations and dominant pole analysis, and realization from open and short-circuit impedance concepts. These are applied to the realization, operation, and optimization of gainband-width products of wide-band amplifiers to obtain specific characteristics such as Butterworth and other functions. *Prep. Bachelor of Science degree in Electrical Engineering or 3.967, Precis of Modern Electrical Engineering II.* Fall quarter

3.841 Linear Active Circuits I-B

The results of 3.840, Linear Active Circuits I-A, are extended to include narrow-band, band pass amplifiers, and feedback amplifier concepts. The effects of feedback upon gain, impedance noise, and stability are developed from return difference and ratio viewpoints utilizing open and short-circuit loop gain concepts. Consideration is given to the synthesis of driving point and transfer functions using active filters, negative impedance converters, and other basic building blocks. *Prep. 3.840, Linear Active Circuits I-A.* Winter quarter

3.842 Linear Active Circuits I (4 q.h. credits)

Offered days. Includes the material given in 3.840, Linear Active Circuits I-A and 3.841, Linear Active Circuits I-B. *Prep. Bachelor of Science degree in Electrical Engineering or 3.976, Precis of Modern Electrical Engineering II.*

Fall and winter quarters

3.843 Linear Active Circuits II

A continuation of the material covered in Linear Active Circuits I-A and I-B. Emphasis will be placed on feedback systems, including multiloop amplifier design. These techniques will be applied to integrated circuit realizations of basic active networks. *Prep. 3.841, Linear Active Circuits I-B or 3.842, Linear Active Circuits I.* Spring quarter

3.845 Active Network Synthesis

Basic methods of active network synthesis are introduced through three commonly used approaches: feedback amplifier, negative impedance convertor, and gyrator; structures of Sallen and Key, Kuh, Linvill, Yanagisawa, Rohrer, Kinariwals, Sepress, and Calahan; consideration of the practical realization of NIC's and gyrators, standard decomposition methods and sensitivity; work of Sandberg, Larky, Newcomb, Daniels, Horowitz, and Thomas. *Prep. 3.381, Network Synthesis I-B and 3.841, Linear Active Circuits I-B or equivalent.* Fall quarter

3.853 Solid State Device Theory and Practice (4 q.h. credits)

This course meets twice weekly. On one night there is a two-hour lecture; on the other, a three-hour lab. The course carries four quarter hours of credit.

A case method study of solid state devices with a laboratory tightly integrated with the classroom work. The methodology developed is fundamental to the discrete and integrated circuit technology. The classroom portion of the course is devoted to junction diode and bipolar transistor theory including the physics of achieving a given design. In the laboratory, the student designs, builds, and tests diodes and transistors to meet certain electrical characteristics. The devices achieved are seldom of commercial quality, but sufficient equipment is available in the laboratory to make practical device processing possible even for completely untrained personnel. *Prep. An undergraduate level background in electronics and semiconductor devices.* Fall quarter

3.854 Solid State Theory and Practice (4 q.h. credits)

The course is offered on the same basis as 03.853 and is a continuation of that course. The central topic is field effect transistors with appropriate design problems for the laboratory. *Prep. 3.853 Solid State Device Theory and Practice.* Spring quarter

3.8G1 Characteristics and Models of Solid State Devices I

This sequence of three courses is designed to develop real insight into the operation of a broad range of semiconductor devices. Important topics in the physics of semiconductors to provide the background necessary for device analysis are discussed. Analysis of fundamental building-block units of which devices are made including the PN junction, the ohmic contact, and the Schottky barrier. Each is examined under reasonable extremes of bias and temperature to establish the electrical behavior expected from such elementary units. *Prep. Bachelor of Science degree in Electrical Engineering or equivalent.*

Fall quarter

3.8G2 Characteristics and Models of Solid State Devices II

Detailed analysis of the bipolar transistor, metal-oxide-semiconductor interface, its influence on the behavior of real junctions, and the various realizations of the field-effect transistor. *Prep. 3.8G1 Characteristics and Models of Solid State Devices I.*

Winter quarter

3.8G3 Characteristics and Models of Solid State Devices III

A continuation of the work of the previous two courses. A detailed analysis of the performance of FET's will permit a critical comparison of field effect and bipolar transistors. Solid state microwave devices; devices that are both unique to microwave applications and the relevant low-frequency elements which require somewhat different analysis at microwave frequencies. An examination of noise in semiconductor devices. *Prep. 3.8G2 Characteristics and Models of Solid State Devices II.*

Spring quarter

3.860 Pulse Processing I

The principles and techniques of pulse-forming and pulse-processing circuits, basic radar, television, digital computation, pulse modulation systems, and data-processing systems. Wave shaping circuits, logic circuits, switching circuits, digital devices, and time base generators will be covered. *Prep. Bachelor of Science degree in Electrical Engineering or 3.975, 3.976, and 3.977, Precis of Modern Electrical Engineering I, II, and III.*

Winter quarter

3.861 Pulse Processing II

Continuation of 3.860, Pulse Processing I, to include digital filters and corre-

lators, pulse transformers, memory devices, and linear delay devices. *Prep. 3.860, Pulse Processing I.* Spring quarter

3.865 Radar Systems I

Emphasis on the systems aspects of radar engineering. Topics covered include antennas; low-noise receivers; high-power transmitters; range, angle, and Doppler tracking systems; search radar systems. Mathematical descriptions are used throughout. *Prep. Background in probability and Fourier analysis.* Fall quarter

3.866 Radar Systems II

Continuation of 3.865, Radar Systems I, a further consideration of systems aspects. The principles of radar detection theory; matched filter and correlation receiver design; radar ambiguity function; radar uncertainty principles; radar waveform synthesis; fundamental accuracy limits; generalized tracking problems. *Prep. 3.865, Radar Systems I.* Winter quarter

3.867 Radar Systems III

Advanced topics in radar engineering including modern tracking techniques, waveform synthesis, multifunction array radar techniques, and selected topics in radar-sensing techniques and devices. *Prep. 3.866, Radar Systems II.* Spring quarter

3.871 Communications Systems I

Primarily concerned with radio communication systems as used in terrestrial and space communication applications. Antenna gain, space loss, cosmic and atmospheric noise, and receiver noise as factors influencing the signal-to-noise ratio in space and satellite repeater systems; channel models are developed for over the horizon systems utilizing ionospheric propagation and exhibiting fading and multipaths; contemporary systems are discussed from the standpoint of signal spectrum, noise power and message ambiguity as exhibited at the output of the intermediate frequency receiver. *Prep. Background in probability and Fourier analysis.* Fall quarter

3.872 Communications Systems II

Primarily concerned with the theoretical aspects of analogue modulation systems used in radio and space communications. First and second threshold effects will be discussed in conjunction with signal-to-noise considerations for amplitude and angle modulated systems. Treatment of frequency feedback and phase-lock loops will be included in the discussion of frequency modulation and detection. Frequency division multiplexing will include sub-carrier pre-emphasis and comparative performance figures for SSSC/FM and FM/FM. *Prep. 3.871, Communications Systems I or 3.900, Applied Probability and Stochastic Processes A.* Winter quarter

3.873 Communications Systems III

Continuation of techniques of 3.872 to cover digital modulation systems and time division multiplexing. Adaptive sampling, aliasing, and interpolation will be discussed along with PAM/FM. Pulse code modulation systems utilizing frequency and phase shifted carriers will be compared under noise conditions. Treatment will be given to the use of codes with special correlation, modulation by sequences, and phase-coherent communication. *Prep. 3.872, Communications Systems II.* Spring quarter

3.875 Electromagnetic Theory A

Maxwell's equations and related electromagnetic laws and relations; basic properties of matter; electromagnetic potentials; the scalar and vector Poisson, D'Alembert, and Helmholtz equations; Green's functions; both mathematical and physical aspects of the theory and their relation to engineering applications. *Prep. Bachelor of Science degree in Electrical Engineering or 3.977, Precs of Modern Electrical Engineering III, Advanced Calculus, and Vector Analysis.*

Fall quarter

3.876 Electromagnetic Theory B

Basic radiation phenomenon including retarded potentials, radiation from moving charges, electromagnetic energy, and energy-related theorems. Propagation of plane waves in media with real and complex constitutive parameters. Fundamental theory of guided waves. *Prep. 3.875, Electromagnetic Theory A.*

Winter quarter

3.877 Electromagnetic Theory (4 q.h. credits)

Offered days. Includes the material given in 3.875 and 3.876, Electromagnetic Theory A and B. *Prep. Bachelor of Science degree in Electrical Engineering or 3.977, Precs of Modern Electrical Engineering III.* Winter and spring quarters

3.878 Advanced Electromagnetic Theory A

More advanced approaches to problems in electromagnetic theory of interest to electrical engineers — for example: waveguide, antennas, diffraction, and scattering; approximation techniques for obtaining useful solutions of field theory problems including integral equation, perturbation, and variational techniques. *Prep. 3.876, Electromagnetic Theory B or 3.877, Electromagnetic Theory.*

Spring quarter

3.879 Advanced Electromagnetic Theory B

Special relativity and relativistic electrodynamics. Radiation from moving charges. Statistical concepts and propagation in random media. Introduction to magnetohydrodynamics and plasma physics. *Prep. 3.878 Advanced Electromagnetic Theory A.*

Fall quarter

3.880 Microwave Theory

Propagation of electromagnetic waves on periodic structures. Propagation on a helix. Waves on electron beams. Coupled-mode theory. Traveling-wave devices. Propagation in anisotropic media. Ferrite devices. *Prep. 3.876, Electromagnetic Theory B or 3.877, Electromagnetic Theory.*

Spring quarter

3.881 Microwave Circuits I

Review of microwave circuit theorems; scattering matrices and applications; eigenvalue problem; symmetrical and miscellaneous junctions; applications of 3-db couplers; polarizers, phase shifters and attenuators; non-reciprocal and ferrite devices. *Prep. 3.876, Electromagnetic Theory B or 3.877, Electromagnetic Theory.*

Winter quarter

3.882 Microwave Circuits II

One-port resonant cavity; transmission cavity; analysis and synthesis of microwave filters; traveling-wave resonators; periodically loaded lines; selected microwave system considerations. *Prep. 3.881, Microwave Circuits I.* Spring quarter

3.883 Advanced Electromagnetic Theory (4 q.h. credits)

Offered days. Includes the material given in 3.878 and 3.879 — Advanced Elec-

tromagnetic Theory A and B. *Prep. 3.876, Electromagnetic Theory B or 3.877, Electromagnetic Theory.* Spring quarter

3.885 Antennas and Environmental Sensors

Fundamental theory of the transient and steady state operation of radiating devices with emphasis on wire type antennas — although more complex structures will also be studied; use of antennas for environmental probes and for mapping and measuring the resources of the earth; remote sensing from radiating structures; use of computers in solving antenna problems. *Prep. 3.876, Electromagnetic Theory B or 3.877, Electromagnetic Theory.* Spring quarter

3.887 Biological Picture Processing

The preparation and meaning of greatly magnified pictures of biological objects. Electron microscope studies of particular biological systems; practical problems in specimen preparation and the limitation of optical and electron optical systems; reconstruction of the three-dimensional structure of the specimen using both real space and Fourier techniques; use of high speed computers in processing and interpreting the pictorial data. As time permits, other optical methods for gathering biological pictures will be discussed. *Prep. Bachelor of Science degree in Engineering or Science.* Spring quarter

3.890 Electromagnetic Wave Propagation I

Topics in wave propagation of prime importance in communications and space physics. Review of wave propagation in a homogeneous medium. Physical processes in the atmosphere. The formation and structure of the ionosphere. Basic magneto-ionic theory. Propagation of waves in a spatially varying medium. Ray theory. *Prep. 10.9N2, Advanced Mathematics or equivalent.* Winter quarter

3.891 Electromagnetic Wave Propagation II

Application of the theory of the oblique incidence of radio waves on the ionosphere, including the effects of the presence of the geomagnetic field, to radio communications. The interpretation of ionograms. Path prediction and field strength computations. Absorption. Top side soundings. Incoherent thermal scatter. Ionospheric irregularities and motions, and their study by space and frequency diversity techniques and other methods. *Prep. 3.890, Electromagnetic Wave Propagation I.* Spring quarter

3.892 Introduction to Digital Computer Programming

Analysis of assorted problems of differing types and discussion of potential solution methods; transformation of chosen solution methods into detailed flow charts; principles of computer programming: logical decision trees, loops, arrays, subroutines, internal checks, error handling, input, output, and the use of library routines; implementation of these principles using the FORTRAN IV language including its advanced features; principles of program testing and the circumvention of language restrictions. (Not open to those who have completed 3.970, Digital Computer Programming I.) *Prep. Bachelor of Science degree in Engineering or Science.* Fall quarter

3.893 Digital Computer Programming I

First quarter of a three-quarter sequence of systems programming and language processors. Topics covered in the sequence include: machine structure, machine language, assembly language; assemblers, macros, macro-processors;

searching and sorting; loaders; data structures, storage allocation; high-level languages; compilers; operating systems; management of memory, processors, devices; multiprocessing and multiprogramming. *Prep. B.S. degree in Engineering or Science and knowledge of FORTRAN IV, ALLOL, or PL/1.*

Fall quarter

3.894 Digital Computer Programming II

Continuation of 3.893. *Prep. 3.893 Digital Computer Programming I.*

Winter quarter

3.895 Digital Computer Programming III

Continuation of 3.894. *Prep. 3.894 Digital Computer Programming II.*

Spring quarter

3.898 Introduction to Combinatorial Mathematics

An introduction to applied combinatorial mathematics. Topics include permutations and combinations, generating functions, recurrence relations, the inclusion-exclusion principle, and Polya's Theory of counting. *Prep. Bachelor of Science degree in Engineering or Science.*

Fall quarter

3.899 Introduction to Optimization Techniques

Selected topics in optimization techniques including: transport networks, matching theory, linear programming, and introduction to dynamic programming. Illustrative applications will be given in the areas of computer science, information processing, operations research and control theory. *Prep. 3.898 Introduction to Combinatorial Mathematics.*

Winter quarter

3.8C1 Mathematical Methods in Electrical Engineering I-A

Complex variable theory; mapping by functions, definite and indefinite integrals, Cauchy integral formula, Laurent series, the residue theorem and branch points. Not open to Northeastern graduates who have completed 3.292. *Prep. Bachelor of Science degree in Engineering or Science.*

Fall quarter

3.8C2 Mathematical Methods in Electrical Engineering I-B

A continuation of 3.8C1 that includes application of complex variable theory to Fourier theory, Hilbert transforms, and conformal transformations in the analysis of linear systems and in electrostatics; the Schwarz-Christoffel transformation, Poisson's integral formula and concept of analytic continuation. *Prep. 3.8C1, Mathematical Methods in Electrical Engineering I-A.*

Winter quarter

3.8C4 Mathematical Methods in Electrical Engineering II-A

Linear algebraic equations; Gauss algorithm; Linear operators in an n -dimensional vector space over infinite and finite fields; characteristic value problem; minimum polynomial; functions of a matrix; Cayley-Hamilton theorem; Sylvester's identity; matrix transformations: equivalence, congruence, similarity; quadratic forms; definiteness; canonical forms under equivalence and congruence transformation; polynomial matrices. *Prep. Bachelor of Science degree in Electrical Engineering.*

Fall quarter

3.8C5 Mathematical Methods in Electrical Engineering II-B

Smith normal form; determinantal divisors; invariant factors; elementary divisors; canonical forms under similarity: companion forms and Jordan form; method of Jordan chains; Segre, Ferrer, and Weyr characteristics; decomposition of a vector space into invariant subspaces. *Prep. 3.8C4, Mathematical Methods in Electrical Engineering II-A.*

Winter quarter

3.8T1 Numerical Methods and Computer Applications I

Survey of numerical methods applied to engineering and scientific problems with emphasis on machine implementation and problem solving; roundoff errors and cumulative errors; difference and summation calculus; roots of polynomials and nonlinear functions; orthogonal functions including polynomials, least squares, and Chebyshev approximation of functions; systems of algebraic equations, matrix notation, and machine implementation; inversion of matrices including iterative methods; sparse matrix techniques. *Prep. Bachelor of Science in Engineering, Mathematics, or Physics; a working knowledge of FORTRAN.*

Fall quarter

3.8T2 Numerical Methods and Computer Applications II

Interpolation; numeric quadrature; numeric integration of ordinary differential equations including predictor-corrector methods; stiff dynamic equations, partial differential equations, approximations, boundary value problems. *Prep.*

3.8T1, *Numerical Methods and Computer Applications I.*

Winter quarter

3.8T3 Numerical Methods and Computer Applications III

Linear and dynamic programming, steepest descent and simplex methods, with application to nonlinear functions in n -dimensional space; eigenvalues and eigenvectors of matrices; approximate location of eigenvalues; stability; Routh-Hurwitz criterion; more specialized techniques including the fast Fourier transform, digital simulation of analog computation, system modelling, etc. *Prep.*

3.8T2, *Numerical Methods and Computer Applications II.*

Spring quarter

3.8T7 Digital Filtering I

Representation of discrete signals and systems; z -transforms and discrete Fourier transforms; difference equations and state space representation of discrete systems; design of digital filters; recursive and nonrecursive. *Prep.*

3.824, *Linear Systems Analysis I or equivalent.*

Fall quarter

3.8T8 Digital Filtering II

Algorithms for fast Fourier transforms, e.g., Cooley-Tukey, Sande-Tukey, etc.; radix two, four and arbitrary algorithms; digital spectra, smoothing techniques, spectral window; effects of quantization truncation and parameter inaccuracies; system performance in the presence of noise; applications to signal processing problems and the solution of partial differential equations. *Prep. 3.8T7, Digital Filtering I or consent of the instructor.*

Winter quarter

3.8T9 Digital Filtering (4 q.h. credits)

This course, offered days, embodies the material in 3.8T7 and 3.8T8, Digital Filtering I and II. *Prep. 3.824, Linear Systems Analysis I or equivalent.*

Spring quarter

The two-part sequence which follows serves to introduce students in engineering and physics to the notions of probability, random variables and stochastic processes. The subject matter is given below.

3.900 Applied Probability and Stochastic Processes A

Introductory probability, sample space and random variables, examples of discrete and continuous probability distribution functions, averages, moments and characteristic function, multivariate distributions, change of variables and functions of variables, central limit theorem, description of stochastic vectors. *Prep. Bachelor of Science degree in Engineering or Science.*

Fall, winter, and spring quarters

3.901 Applied Probability and Stochastic Processes B

General concepts of stochastic processes, stationarity and ergodicity, stochastic continuity and differentiation, the Gaussian process, linear systems with stochastic inputs, correlation functions and power spectra, stochastic orthogonality and linear mean-square estimation filtering and prediction. *Prep. 3.900, Applied Probability and Stochastic Processes A.* Fall, winter and spring quarters

3.902 Applied Probability and Stochastic Processes (4 q.h. credits)

Offered days. Includes the material given in 3.900, Applied Probability and Stochastic Processes A and 3.901, Applied Probability and Stochastic Processes B. *Prep. Bachelor of Science degree in Engineering or Science.*

Fall, winter, and spring quarters

3.903 Information Theory

Deals principally with three aspects of information theory; the statistical description of sources and the probabilistic measure of their information contents, the determination of channel capacity, and the fundamental coding theorems. *Prep. 3.900, Applied Probability and Stochastic Processes A or 3.902, Applied Probability and Stochastic Processes or Probability.* Fall quarter

3.904 Error Correcting Coding

Error correcting codes and their decoding techniques which show promise for practical applications in digital communication and computer systems. Emphasis on the linear block codes based on the algebraic structure; cyclic codes for random error correction (B-C-H codes) and burst error correction. Some knowledge of elementary aspects of modern algebra is desirable but not necessary. *Prep. Bachelor of Science degree in Engineering or Science.* Winter quarter

3.905 Information Theory and Coding (4 q.h. credits)

Offered days. Includes the material given in 3.903, Information Theory and 3.904, Error Correcting Coding. *Prep. 3.900, Applied Probability and Stochastic Processes A or 3.902, Applied Probability and Stochastic Processes.* Spring quarter

3.906 Detection and Estimation Theory A

This course presents the classical theory of signal detection and estimation. Particular topics include: likelihood ratio tests for detection of known or random signals; calculation of error probabilities; the signal selection problem; and maximum likelihood estimation of signal parameters. *Prep. 3.901, Applied Probability and Stochastic Processes B or 3.902, Applied Probability and Stochastic Processes.* Winter quarter

3.907 Detection and Estimation Theory B

This course is a continuation of 3.906 stressing application of the theory. Particular topics include: synthesis of an adaptive receiver; ambiguity function; estimation of angle modulated signals; and selection of features and training algorithms in pattern recognition. *Prep. 3.906, Detection and Estimation Theory A.* Spring quarter

3.908 Special Topics in Communication Theory

Current aspects of communication theory not covered in previous courses. Subject matter may change from year to year. Subjects in 1974-75 and 1975-76 are:

Fall quarter — Applications in Optics

Characterization and processing of optical signals. Topics include a linear system theory of imaging; the lens as a Fourier transformer; modulation

transfer function; phase distortions; film and diode detector noise; coherent (holographic) and incoherent filtering; synthetic apertures; sampled images (aliasing, sampling jitter, noise); digital picture processing (detection, filtering, enhancement); and bandwidth comparison for transmission or storage. *Prep. 3.901 Applied Probability and Stochastic Processes B.*

Spring Quarter — Topics on Coding

Convolutional coding and probabilistic decoding, arithmetic codes, combination of codes, coding for ranging and synchronization. *Prep. 3.904, Error-Correcting Coding or 3.905, Information Theory and Coding.*

3.9C1 — Data Transmission I

Deals with the theoretical and practical aspects of digital data transmission in the presence of channel distortion and additive noise. Topics covered in this quarter include the basic binary and M-ary modulation techniques namely, PSK, PAM, FSK, orthogonal and bi-orthogonal signaling, and their performance in an additive Gaussian noise channel; signal design techniques for band limited channels; Nyquist criteria; effect of channel amplitude and delay distortion on performance; and adaptive equalization. *Prep. 3.901, Applied Probability and Stochastic Processes B or 3.902, Applied Probability and Stochastic Processes.*

Fall quarter

3.9C2 — Data Transmission II

Discussion of several adaptive equalization algorithms for combatting intersymbol interference; maximum likelihood sequence estimation and the Viterbi algorithm; the characterization of fading multipath channels; diversity reception techniques; characterization of atmospheric and man-made (impulsive) noise in radio communications, its effect on error-rate performance; and receiver processing techniques for combatting impulsive noise. *Prep. 3.901, Applied Probability and Stochastic Processes B or 3.902, Applied Probability and Stochastic Processes.*

Winter quarter

3.909 Detection and Estimation Theory (4 q.h. credits)

Offered days. Includes the material given in 3.906 and 3.907, Detection and Estimation Theory A and B. *Prep. 3.901, Applied Probability and Stochastic Processes B or 3.902, Applied Probability and Stochastic Processes.*

Winter quarter

3.910 Nonlinear Systems I

Operators and functionals. Functional power series representation of nonlinear systems. Functional representation of the response of a nonlinear system when its input is either a constant, a sinusoid, a transient. System transforms. Applications to the analysis and synthesis of nonlinear systems in terms of functional power series. *Prep. An undergraduate course in Signals and Systems and 3.900, Applied Probability and Stochastic Processes A or equivalent.*

Fall quarter

3.911 Nonlinear Systems II

Nonlinear systems with random inputs. Functional representation of the response of a nonlinear system when its input is a random process. Orthogonal systems of functionals. Representation and analysis of nonlinear systems in terms of orthogonal systems of functionals. The optimum nonlinear filter, predictor, and general operator. Special classes of nonlinear systems. Determination of optimum nonlinear systems for generalized error criteria. *Prep. 3.910, Nonlinear*

Systems I and either 3.901, Applied Probability and Stochastic Processes B or 3.902, Applied Probability and Stochastic Processes. Winter quarter

3.912 Nonlinear Systems III

Functional analysis of systems characterized by nonlinear differential equations. Operator approach to system theory and its relationship to differential equation representations. The methods of iteration in nonlinear theory and its application to feedback systems. *Prep. 3.911, Nonlinear Systems II.* Spring quarter

3.913 Optical Storage and Display

Survey of materials and methods for the storage and display of information. Topics included are: photographic film, holograms, storage tubes, magneto-optical films, photochromic materials, electro-optical crystals, evaporated thin films and liquid crystals. *Prep. 3.914, Electro-Optics I or equivalent.* Fall quarter

3.914 Electro-Optics I — Introduction

Introduction to the principles of electro-optical systems; imaging and non-imaging devices. Topics included are: optical imaging, sources, detectors, transmission, absorption scattering, polarization, system evaluation and limitation. *Prep. 10.8A4, Advanced Mathematics or 3.823, Mathematical Methods in Electrical Engineering or equivalent.* Spring quarter

3.915 Electro-Optics II — Imaging Devices

Detailed theory of image formation; evaluation of optical instruments; detailed description of representative systems; test procedures and critical alignment techniques. *Prep. 3.914, Electro-Optics I or equivalent.* Fall quarter

3.916 Fourier Optics I

This two-quarter sequence covers: optical diffraction and imaging problems as linear systems; necessary tools of Fourier Analysis and linear systems analysis which occur when solving the scalar wave equation; waves and their properties; reflection, refraction, polarization, and propagation of waves; foundations of scalar diffraction theory—including Fresnel and Fraunhofer diffraction, interferometry, division of amplitude, division of wavefront, interferometric instrumentation, Fourier transforming, image properties of lenses, coherent and incoherent imaging; and advanced topics in the application of communication theory to optical problems, transfer and spread functions, spatial filtering, and holography. *Prep. 3.915, Electro-Optics II or equivalent.* Winter quarter

3.917 Fourier Optics II

Continuation of 3.916. *Prep. 3.916, Fourier Optics I.* Spring quarter

3.918 Experimental Optics I

Should be taken concurrently with 3.915, Electro-Optics II.
1 hour lecture, 2 hours laboratory. Fall quarter

3.919 Experimental Optics II

Should be taken concurrently with 3.916, Fourier Optics I.
1 hour lecture, 2 hours laboratory. Winter quarter

3.920 Experimental Optics III

Should be taken concurrently with 3.917, Fourier Optics II.
1 hour lecture, 2 hours laboratory. Spring quarter

The laboratory course provides practical experience in experimental optics to supplement the theory developed in the electro- and Fourier optics lectures. Topics include: geometrical properties of lenses, aberrations, and resolution measurements; diffraction effects in optics and in lens systems; interferometric techniques applied to precise optical measurements and to image evaluation. Optical transfer function, spatial optical filtering and Fourier transformation concepts are studied in the laboratory; investigation of holographic techniques and the coherence of light.

3.921 Optical Properties of Matter I — Crystals

Optics of crystals; classification and effects of crystal symmetry on optical properties; classical description of wave propagation in crystals; applications of the theory to modulation, pulse generation, non-linear optics. *Prep. 3.914, Electro-Optics I.* Fall quarter

3.922 Optical Properties of Matter II

Introduction to electro-optical and magneto-optical effects in material media; linear and non-linear optical materials; elasto-optic and acousto-optical materials; polarization and propagation effects; modulation. *Prep. 3.921, Optical Properties of Matter I — Crystals.* Winter quarter

3.923 Optical Properties of Matter III

Thin films and optical fibers; multilayer filters; dichroics; integrated optics. *Prep. 3.922, Optical Properties of Matter II.* Spring quarter

3.924 Advanced Topics in Electro-Optics

Special topics in modern optics and optical techniques requiring the presentation of a paper by participants at termination of the course. *Prep. Consent of the Director of the Electro-Optics Program.* Offered by special arrangement

Additional courses on the optics sequence are 3.980, 3.981, 3.982, 3.983, and 3.984.

3.925 Power Circuit Analysis I

Fundamental concepts of single-phase and polyphase power systems; definitions of terms; use of per unit quantities; equivalent circuits of symmetrical 3-phase systems; introduction to symmetrical components; short circuits on systems with a single power source. *Prep. Bachelor of Science degree in Electrical Engineering.* Fall quarter

3.926 Power Circuit Analysis II

This course is a continuation of 3.925, Power Circuit Analysis I. Sequence impedances of various power-system elements are considered from application point of view; unsymmetrical faults on otherwise symmetrical 3-phase systems; open conductors and asymmetrical connections and loadings; analysis of simultaneous faults on 3-phase systems; 2-phase systems. *Prep. 3.925, Power Circuit Analysis I.* Winter quarter

3.927 Power Circuit Analysis III

This course is a continuation of 3.926, Power Circuit Analysis II. Introduction to Clarke components and applications in analysis of asymmetrical systems and faults; transmission line theory; protective relaying; fundamentals of system stability. *Prep. 3.926, Power Circuit Analysis II.* Spring quarter

3.928 Analysis of Power Systems (4 q.h. credits)

Offered days. This course is designed to provide the basic material, including special mathematical techniques, applicable to the solution of problems associated with power systems. The sequence-impedance characteristics of various power-system elements are investigated with emphasis on application rather than design. Abnormal situations including simultaneous faults and system transients are treated in depth, making use of Clarke components and modified Clarke components as well as symmetrical components. Polyphase transmission line theory, system protection and system stability are introduced and discussed briefly. *Prep. Bachelor of Science degree in Electrical Engineering.*

Fall quarter

3.930 Power System Planning

Engineering and economic aspects underlying system development and planning. Probability methods of determining installed and spinning-reserve requirements. Mathematical models of system operation for production-costing studies. Detailed examples include economic comparison of nuclear and fossil-fired plants, the role of pumped-hydro generation, power pooling, and coordinated planning of interconnected systems, and the functions of high-voltage and EHV transmission in planning and operation. *Prep. 3.925, Power Circuit Analysis I.*

Spring quarter

3.931 Power System Planning (4 q.h. credits)

Offered days. Includes the material given in 3.930 but with more extensive and in-depth coverage. *Prep. 3.928, Analysis of Power Systems or equivalent.*

Spring quarter

3.932 Power Systems Protection

Consideration of protection applied to generation, transmission, and distribution. Investigation of the characteristics and operating principles of various methods of protective relaying; analysis of current techniques pertaining to system protection. *Prep. 3.927, Power Circuit Analysis III or equivalent.*

Fall quarter

3.933 Power System Transients

Transients in power systems due to system switching, lightning, or faults. Traveling-wave phenomena; insulation coordination; overvoltages due to disturbances on the system; surge protection. *Prep. 3.927, Power Circuit Analysis III or equivalent.*

Winter quarter

3.935 Computers in Power Systems I

Techniques used in solving power system problems with a digital computer. Basic concepts of matrix algebra are examined, followed by methods for the formation of incidence and network matrices; treatment of three-phase balanced and unbalanced networks in matrix form. *Prep. Bachelor of Science degree in Electrical Engineering or equivalent.*

Fall quarter

3.936 Computers in Power Systems II

Consideration of the short-circuit problem; bus impedance matrix domain, modification of bus impedance matrix for line-out, end-of-line faults, additions, removals, impedance changes; matrix reductions; features of working short-circuit programs. *Prep. 3.935, Computers in Power Systems I.*

Winter quarter

3.937 Computers in Power Systems III

The solution of simultaneous linear and non-linear algebraic equations, and

numerical techniques for solving differential equations. Digital computer application in special fields is treated, including turbine-generator control, economic dispatch and system security, and use as part of a hybrid digital-analog system. *Prep. 3.936, Computers in Power Systems II.* Spring quarter

3.938 Computer Control and Analysis of Power Systems (4 q.h. credits)

This course, offered days, combines the evening courses 3.935, 3.936, 3.937. *Prep. Bachelor of Science degree in Electrical Engineering or equivalent.* Spring quarter

3.940 Electric Machinery Theory I

Review of electromagnetic theory as applied to electrical machines; in-depth analysis of the a-c induction machine; generalized machine and d-q transformations. *Prep. Bachelor of Science degree in Electrical Engineering or 3.975, 3.976, and 3.977, Precis of Modern Electrical Engineering I, II, and III.* Fall quarter

3.941 Electric Machinery Theory II

Analysis of the principles of operation of synchronous machines with special reference to d-q and symmetrical components; consideration of the transient behavior of the machine. *Prep. 3.940, Electric Machinery Theory I.* Winter quarter

3.942 Electric Machinery Theory III

Dynamic behavior of machines; comprehensive treatment of the problem of stability as applied to electric machinery. *Prep. 3.941, Electric Machinery Theory II.* Spring quarter

3.943 Advanced Power Laboratory

Offered days. In-depth investigations of the steady-state and dynamic modes of operation of rotating machines. Polyphase rectification and control circuits. Experimentation in other related power areas. *Prep. Bachelor of Science degree in Electrical Engineering.* All quarters

3.944 Special Topics in Power

Offered days. (Part-time students may enroll in this course only by special arrangement.) Directed reading and discussion of topics of special interest in the power field. Series of lectures by guest speakers from industry on topics of particular interest to the power student. *Prep. Permission of instructor.* All quarters

3.945 Power System Transient Stability

Transient system models; small- and large-scale oscillations; solution of swing equation for single and multi-generator cases; load frequency and voltage controllers and transient stability. *Prep. 3.927, Power Circuit Analysis III or equivalent.* Fall quarter

3.946 MHD Energy Conversion

Theory of operation of MHD generators; fluid mechanics; electrodynamics; channel design; magnet design; and applications. *Prep. Bachelor of Science degree in Electrical Engineering or equivalent.* Winter quarter

3.947 High Voltage DC Power Transmission

Fundamental concepts of high-voltage DC power transmission; rectifier performance; inverter performance; method of regulation; protection; reactive power and filter requirements. *Prep. 3.927, Power Circuit Analysis III or equivalent.* Spring quarter

3.950 Systems Analysis I-A

Review of probability and statistics. Elements of Markov processes, queuing as a Markov process. Finite and infinite queue systems, multiple-server, parallel and sequential queuing; fundamentals of reliability theory. *Prep. Bachelor of Science degree in Engineering or Science.* Fall quarter

3.951 Systems Analysis I-B

Flow-graph representation of queuing systems, equivalence of flow-graph and analog-computer representation; fundamental concepts in game theory; solution of rectangular games; pure and mixed strategies, maximin and minimax principle; zero and non-zero-sum games, infinite games; transformation of games into linear programming problems. Other methods of solving competitive-situation problems. *Prep. 3.950, Systems Analysis I-A.* Winter quarter

3.952 Systems Analysis II

Modelling of systems problems in terms of linear programming approach. Transportation problem; graphical representation and solution of linear-programming problems; allocation problem; simplex method; concept of duality and its use in linear programming. *Prep. 10.8A4, Advanced Mathematics or 10.9N2, Advanced Mathematics.* Spring quarter

3.953 Systems Analysis III

Optimization of stochastic systems. Markov-process approach to the analysis of probabilistic systems. Z-transform analysis of Markov processes. Solution of sequential decision processes by value and policy iteration. Single-chain and multi-chain systems. Sequential decision processes with discounting. Machinery and car replacement problem, and other applications. *Prep. 3.950, Systems Analysis I-A, 3.952, Systems Analysis II, 10.8G1, Probability or equivalent.* Fall quarter

3.954 Systems Analysis (4 q.h. credits)

Offered days. Includes the material given in 3.950 and 3.951 — Systems Analysis I-A and I-B. *Prep. Bachelor of Science degree in Engineering or Science.* Spring quarter

3.957 Control System Analysis

Classical analysis techniques for continuous and sampled-data control systems. Discussion of stability criteria; application of root-locus and Bode methods for complementary time and frequency-domain analysis. Consideration of non-linear systems and development of techniques for stability analysis. Computer simulation of typical control systems will be emphasized. *Prep. Bachelor of Science degree in Engineering; knowledge of transform analysis and some familiarity with FORTRAN.* Fall quarter

3.958 Control System Synthesis

A review of cascade and feedback compensation techniques with the use of classical criteria for design of continuous and sampled-data control systems. Consideration of the multiple-input problem. A survey of pole-zero synthesis methods, and comparison with other techniques. Computer simulation of design examples. *Prep. 3.957 Control System Analysis or equivalent.* Winter quarter

3.959 Control Systems I (4 q.h. credits)

Includes the material given in 3.957, Control System Analysis and 3.958, Con-

trol System Synthesis. Open to qualified undergraduate students. *Prep. Knowledge of transform analysis and some familiarity with FORTRAN.* Fall quarter

3.960 Control System Practice

A further study of control systems with emphasis on the practical aspects of control system design. Discussion of digital compensation and computer-in-the-loop realizations. Consideration of system hardware and software problems. Case studies and a field trip will be included. *Prep. 3.959 Control Systems I or equivalent.* Spring quarter

3.961 Optimal Control Theory

Introduction to optimal control theory with reference to aerospace and process control applications. Variational calculus development of the maximum principle. Numerical solutions using dynamic-programming and steepest-descent algorithms. The optimal linear regulator problem and the matrix Riccati equation. *Prep. 3.959 Control Systems I or equivalent.* Fall quarter

3.962 Control Systems II (4 q.h. credits)

Includes the material given in 3.960, Control System Practice and 3.961, Optimal Control Theory. *Prep. 3.959, Control Systems I or equivalent.* Winter quarter

3.963 Stochastic Control Theory

Statistical models for random signals; representation of dynamic systems excited by stochastic inputs. Optimal filtering, prediction and smoothing for discrete and continuous systems. Observer theory and feedback of estimated states for effective closed-loop control in a noisy environment. *Prep. 3.900, Applied Probability and Stochastic Processes A or equivalent.* Winter quarter

3.964 Estimation, Identification, and Control

Estimation theory for dynamic systems based on Bayesian and maximum likelihood methods. The system identification problem. Implementation of numerical algorithms for parameter identification and adaptive control. *Prep. 3.963, Stochastic Control Theory.* Spring quarter

3.965 Control Systems III

Includes the material given in 3.963, Stochastic Control Theory and 3.964, Estimation, Identification, and Control. *Prep. 3.900, Applied Probability and Stochastic Processes A or equivalent.* Spring quarter

3.967 Switching Circuits I

Logical design of combinational switching circuits, including minimization and decomposition of switching functions; multiple output networks; symmetric networks; threshold logic. *Prep. Bachelor of Science degree in Engineering or Science.* Fall quarter

3.968 Switching Circuits II

Logical design of sequential switching circuits, including the finite-state machine model; iterative networks; capabilities and limitations of finite-state machines; state equivalence; synthesis of asynchronous sequential circuits; state assignment problem and partition theory; machine decomposition. *Prep. 3.967, Switching Circuits I.* Winter quarter

3.969 Switching Circuits III

Selected topics from the theory of finite automata, possibly including such topics

as machine experiments; information lossless machines; linear sequential machines; finite-state recognizers. *Prep. 3.968, Switching Circuits II and Linear Algebra background such as covered in 3.823, Math Methods in Electrical Engineering.* Spring quarter

3.972 Electronic Digital Computers I

Basic structural aspects and components; coding of digital information; fixed and floating point digital arithmetic and algorithms; speed-up algorithms in binary and alternative codes; switching functions, Boolean logic and minimizations; linear, sequential synchronous, and asynchronous — including simple and multiple output circuits; central processor design examples. *Prep. Bachelor of Science degree in Engineering or Science.* Fall quarter

3.973 Electronic Digital Computers II

Computer description languages; elementary machines and computer organizations; memories; hierarchies; essential features of automatic programming; addressing techniques, cycle times, operating speed, and cost/bit comparisons; special function memories; structural design of a general purpose computer; instruction formats and repertoires, program sequencing, control of data, and instruction flow; execution of several types of instructions; soft ware and hardware interaction. *Prep. 3.972 Electronic Digital Computers I.*

Winter quarter.

3.974 Electronic Digital Computers III

Computer design considerations in different types of logic families and devices i.e., DDL, DTL, TTL, etc.; digital system designs using medium and large scale integration; control logic, hybrid computers; basic simulation studies of physical and digital systems; interaction between computer memories, central processing units and peripheral equipment. *Prep. 3.973 Electronic Dig. Comp. II*

Spring quarter

3.975 Precis of Modern Electrical Engineering I

Prep. Bachelor of Science degree in Engineering or Science plus knowledge of matrix algebra. Fall quarter

3.976 Precis of Modern Electrical Engineering II

Prep. Bachelor of Science degree in Engineering or Science. Winter quarter

3.977 Precis of Modern Electrical Engineering III

Prep. Bachelor of Science degree in Engineering or Science. Spring quarter

3.978 Precis of Modern Electrical Engineering IV

Prep. Bachelor of Science degree in Electrical Engineering or Science.

Spring quarter

The preceding four precis courses are intended primarily for those whose undergraduate major was in an engineering or scientific field other than electrical engineering. They are also recommended for students 5 to 10 years away from their bachelor's degree in electrical engineering who feel the need for a review of electrical science. They are open only to students in these categories. The material is basically undergraduate in nature but the viewpoint and depth are at the mature level appropriate to graduate students. Part I deals with the theory of electric circuits and linear systems, Part II with electronics, Part III

with field theory from the engineering viewpoint, and Part IV with communication theory especially spectral analysis correlation and modulation.

3.979 Electronic Digital Computers (4 q.h. credits)

This course, offered days, embodies the material in 3.972 and 3.973 — Electronic Digital Computers I and II. *Prep. Bachelor of Science degree in Engineering or Science.* Fall and winter quarters

3.980 Optical Instrumentation Design Concepts

An introduction to the design of optical instrumentation. Principles and basic concepts rather than a rundown of known optical systems. In sequence the topics are: introduction, mechanical shock and vibration, kinematic designs, application of third order aberrations, simple optical ray tracing, optical testing, tolerances, optical instrumentation, philosophy, functional design, design for quantity production, quality assurance, "special order" design, industrial design, examples and exercises. *Prep. 3.915, Electro-Optics II.* Spring quarter

3.981 Principles of Optical Detection I — Application

Laws governing radiation and radiometry; properties of real radiation sources; detailed description of detection devices (image forming and signal generating); noise; contrast and MTF; detection systems (imaging devices and ranging devices); electro-optical detector systems analysis. *Prep. 3.915, Electro-Optics II or equivalent.* Winter quarter

3.982 Principles of Optical Detection II — Theory

Review of detector parameters; statistics of detector noise; practical considerations in real detectors; detection, resolution and recognition of signals; heterodyne detection and parametric amplification; sub-nanosecond pulse detection; calibration of electro-optical detectors; detectors as system components. *Prep. 3.981, Principles of Optical Detection I.* Spring quarter

3.983 Fourier Optics III

The third in a series covering current topics of interest in this field and optical instrumentation. Application of coherence phenomena to optical instrumentation such as microdensitometers, microscopes, viewers, cameras, spectrophotometric and interferometric instruments; applications of holography, optical data processing and computing, holographic memories, optical modulation, noise and its effects on data collection, synthetic aperture optics and medical application of laser optics. *Prep. 3.917, Fourier Optics II.* Fall quarter

3.984 Spectroscopic Instrumentation

Survey of optical instrumentation employed in analysis and control situations; modern methods of spectrometry and interferometry; optimization of analytical systems; topics in electron spectroscopy, X-ray spectroscopy, microwave spectroscopy, and related fields. *Prep. Bachelor of Science degree in Engineering or Science.* Winter quarter

3.985 Fundamentals of Automatic Digital Computation I — Language Models

Review of sets, relations, and graphs. Overview of compiling — lexical, syntactic, and semantic aspects. Languages as sets of strings; grammars as finite descriptions; the hierarchy of grammar types; deterministic and nondeterministic recognizers. Regular languages and regular expressions. Algebraic operations, equational characterization, closure properties, and equivalence relations.

Context-free grammars and block-structured programming languages. Defining equations, normal forms, construction of recognizers from pushdown automata. Ambiguity, determinism, closure properties. *Prep. 3.983 Digital Computer Programming I.* Fall quarter

3.986 Fundamentals of Automatic Digital Computation II — Translation

Syntax-directed translation schemas for context-free languages. Extended regular expressions for lexical analyzers. Early's algorithm for nondeterministic grammars. DeRemer's algorithm for deterministic bottom-up parsing. Recursive functions of regular expressions for top-down translation. Virtual machine techniques for intermediate language interpretation. *Prep. 3.985 Fundamentals of Automatic Digital Computation I.* Winter quarter

3.987 Fundamentals of Automatic Digital Computation III — Computability

Review of algorithms and procedures. Turing machine construction techniques. Universal machines and the halting problem. Equivalence to Type 0 grammars. Solvable and unsolvable problems. Computable numbers and arithmetization of turing machines. Recursive functions and conditional expressions. Introduction to structured program validation techniques. *Prep. 3.985 Fundamentals of Automatic Digital Computation I.* Spring quarter

3.988 Special Topics in Computer Science

Aspects of Computer Science not covered in other courses. The subject matter may change from year to year. Fall, winter, and spring quarters

3.989 Computer Peripherals

Survey of various types of modern computer peripherals, systems considerations, displays (CRT; control units, editing features, graphics, etc.); mass storage (magnetic surfaces; flying heads, recording techniques, disks; file organization, search strategies, mass storage, software, etc.); communications terminals (modems, control procedures, store and forward, multiplexers, etc.); tape units (types, consideration of cost vs. performance, tape labels and formats, magnetic recording on tapes, design features, etc.); future trends in peripherals. *Prep. Bachelor of Science degree in Electrical Engineering or related engineering or sciences.* Spring quarter

3.990 Seminar I

A library survey of a selected topic in the general field of electrical engineering with an oral presentation based on this survey. Participation in the departmental seminar program of guest lecturers. *Prep. Bachelor of Science degree in Engineering or Science.* Fall and spring quarters

3.991 Seminar II

The preparation of a research paper suitable for publication in a professional journal, plus an oral presentation of this report. *Prep. 3.990, Seminar I.* Winter and spring quarters

3.993 Doctoral Seminar I

Two hours per week of presentation and discussion of topics at a level compatible with a doctoral program. Subject matter may cover a wide range of scientific and engineering fields. (Only S or F grades will be assigned for this course.) *Prep. Passing of Ph.D. Qualifying Exam.* Fall quarter

3.994 Doctoral Seminar II

Continuation of 3.993, Doctoral Seminar I. (Only S or F grades will be assigned for this course.) *Prep.* 3.993, *Doctoral Seminar I.* Winter quarter

3.995 Master's Thesis

Analytical and/or experimental work conducted under the auspices of the department. *Prep.* *Bachelor of Science degree in Engineering or Science.*
Fall, winter, and spring quarters

3.996 Doctoral Thesis

Theoretical and/or experimental work conducted under the auspices of the department. *Prep.* *Passing of Ph.D. Qualifying Exam.*
Fall, winter, and spring quarters

3.997 Doctoral Reading

Material approved by the candidate's adviser. (Only S or F grades will be assigned for this course.) *Prep.* *Passing of Ph.D. Qualifying Exam.*
Fall, winter, and spring quarters

3.998 Special Problems in Electrical Engineering

Theoretical or experimental work under individual faculty supervision. *Prep.* *Consent of dept. chairman.* Fall, winter, and spring quarters

3.999 Electrical Engineer Degree Thesis Research. *Prep.* *Admission to Engineer Degree Program.* Fall, winter, and spring quarters

CHEMICAL ENGINEERING

4.801 Advanced Chemical Engineering Calculations (4 q.h. credits)

The study of complex material and energy balances is undertaken with the view to apply these to actual plant conditions. *Prep.* *Bachelor of Science degree in Chemical Engineering, including Differential Equations.*

4.802 Special Topics in Chemical Engineering Mathematics (4 q.h. credits)

Formulation and solution of problems involving advanced calculus as they arise in chemical engineering situations. Methods covered will include ordinary differential equations, series solutions, complex variables, Laplace transforms, partial differential equations, and matrix operations. Emphasis will be placed on methods for formulating the problems. It will be assumed that the student has been exposed to some of these topics in appropriate mathematics courses. *Prep.* 10.147 *Mathematical Analysis or equivalent.* Offered yearly, fall quarter

4.803 Numerical Techniques in Chemical Engineering (4 q.h. credits)

Digital computer applications to chemical engineering problems. Topics covered include location of roots of linear and non-linear equations, numerical integration, and curve-fitting techniques with emphasis on the numerical solution of ordinary and partial differential equations and to the subject of linear algebra. *Prep.* *Bachelor of Science degree in Engineering or Science.*

Offered yearly, winter quarter

4.806 Optimization Techniques (4 q.h. credits)

Several mathematical optimization techniques are developed and applied to chemical engineering problems. Emphasis on a thorough understanding of a

single, representative technique selected from among many within its class. Topics include single variable search (Fibonacci Search), multi-dimensional search (Pattern Search), linear systems (Linear Programming) and sequential operations (Dynamic Programming). *Prep. Bachelor of Science degree in Engineering or Science.*
Offered yearly, spring quarter

4.811 Special Topics in Chemical Engineering Thermodynamics (4 q.h. credits)

Classical thermodynamics as a method of approach to the analysis of processes of interest to chemical engineers. A study of chemical and phase equilibria involving the various states of matter; prediction and correlation of physical, chemical, and transport properties of gases and liquids; elementary concepts of quantum and statistical mechanics to interpret the empirical properties of classical thermodynamics. Fundamental principles are reviewed to the extent needed. *Prep. Undergraduate Chemical Engineering Thermodynamics.*

Offered yearly, winter quarter

4.821 Corrosion Fundamentals (2 q.h. credits)

Economic factors, basic theories, types, behaviors of specific systems, and protection against corrosion are studied. Wherever possible, engineering applications of the principles are emphasized. *Prep. Bachelor of Science degree.*

4.823 Transport Phenomena (4 q.h. credits)

A consideration of the relationships of mass, momentum, and energy transfer. Fundamental equations of change covering the transport of momentum, heat, and mass are developed to illustrate the essential unity of the transport processes. Molecular, microscopic, and macroscopic systems are studied. It will be seen that much of the theory behind the engineering calculations on which the unit operations of chemical engineering are based can be organized and integrated in terms of equations of change. *Prep. Advanced Mathematics and Unit Operations or equivalent.*
Offered yearly, winter quarter

4.825 Sampled-Data Process Control (2 q.h. credits)

Signal sampling; z-transformation; pulse transfer functions; open and closed loop systems; stability; frequency and z-domain design methods. *Prep. Undergraduate Process Control or permission.*

4.826 Experiments in Process Control (2 q.h. credits)

Laboratory experiments related to controllers, control valves, transmitters, attainment of process dynamics by various methods, and control loop performance are performed and analyzed. *Prep. Undergraduate Process Control or permission.*

4.827 Chemical Process Control I (2 q.h. credits)

Review of classical control techniques; state variable representation and analysis of continuous systems with applications to process control. *Prep. Undergraduate Process Control or permission.*

4.828 Chemical Process Control II (2 q.h. credits)

Frequency domain process dynamics and control system analysis; feedforward and cascade control applications; associated papers from the chemical engineering literature. *Prep. 4.827 Chemical Process Control I or permission.*

4.829 Special Topics in Chemical Process Control (4 q.h. credits)

Review of classical control techniques; state variable representation and analysis of continuous systems with applications to process control. Frequency domain process dynamics and control system analysis; feedforward and cascade control applications; associated papers from the chemical engineering literature. *Prep. Undergraduate Process Control or permission.*

4.830 Advanced Topics in Chemical Process Control (4 q.h. credits)

Topics related to the analysis and synthesis of sampled-data process control systems; associated papers from the chemical engineering literature. *Prep. 4.829 Special Topics in Chemical Process Control or permission.*

4.832 Chemical Data Estimation (2 q.h. credits)

Methods of obtaining physical and thermodynamic properties of chemical compounds and systems without resorting to laboratory investigation. Latest empirical relationships and physical and thermodynamic laws are introduced to obtain data for plant design and other chemical and engineering uses. *Prep. Bachelor of Science degree.*

4.833 Research Techniques I (4 q.h. credits)

The essential techniques of research including experimentation, mathematical modeling, data reduction, and graphical presentation techniques. For students in the non-research options (M.S. and D.Eng.). *Prep. Bachelor of Science degree and registration in non-thesis M.S. or D.Eng. program.* Offered yearly, all quarters

4.834 Research Techniques II (4 q.h. credits)

Continuation of 4.833. *Prep. 4.833.*

Offered yearly, all quarters

4.835 Analytical and Numerical Techniques (4 q.h. credits)

For students interested in solving comprehensive problems using computer methods. Problems solved in the course will be based on the interest of the students and staff and will be individual. *Prep. Bachelor of Science degree and knowledge of digital computer programming.*

4.840 Advanced Management Techniques in the Chemical Industry (4 q.h. credits)

Management techniques applied to the chemical industry. Special attention to management of research organizations and to management of engineering services, such as design, computer, and related activities. *Prep. Graduate standing.* Offered yearly, winter quarter

4.845 Advanced Plant Design Concepts (4 q.h. credits)

Modern approaches to plant design; computer-oriented design, analysis and simulation of chemical processes, use of strategy decision making in design, advanced scheduling and planning techniques. *Prep. Undergraduate plant design course, knowledge of digital computer programming.*

Offered yearly, spring quarter

4.850 Chemical Process Pollution Control (Water) (4 q.h. credits)

Provides chemical engineering students with basic fundamentals for handling environmental problems in the chemical process industries. Water quality requirements and industrial waste characteristics; wastewater treatment processes applicable to environmental engineering; biological treatment processes and equipment; comprehensive design problems involving biological and tertiary

treatment; the economics of water treatment and reuse. *Prep. Graduate standing in Chemical Engineering. Open to selected ChE seniors.*

Offered 1974-75, spring quarter

4.860 The Energy Crisis: A Survey (2 q.h. credits)

The energy resources of the United States in comparison to the projected demands upon them over the next two decades. Energy sources alternative to fossil fuels such as: nuclear power, hydropower, geothermal and solar power are discussed with regard to the feasibility of their extensive application by the year 2000. Focus upon technical requirements, and economic and environmental impact. *Prep. Bachelor of Science degree.*

4.861 The Energy Crisis: Fuel to Fuel Conversion (2 q.h. credits)

Energy problems associated with the oil, gas, and coal industries. The relative merits of various processes for converting one fuel to another, including the gasification of coal to produce either a low-BTU gas or pipeline quality gas. Production of oil from oil shale, coal, and tar sands. *Prep. Bachelor of Science degree.*

4.862 The Energy Crisis: Solar Energy (2 q.h. credits)

The role of solar energy as a future energy resource in relation to its present state of development. The characteristics of solar radiation and methods of collecting, storing and converting the energy. Emphasis on documented technical and economic experience with solar energy reported in the literature. Current research proposals aimed at harnessing the sun's energy. *Prep. Bachelor of Science degree.*

4.890 Seminar in Chemical Reactor Analysis (4 q.h. credits)

Effects of fluid mixing, temperature and reaction rate model on the performance of chemical reactors. Specific topics covered are macro- and micromixing in homogeneous media, boundary conditions for tubular flow reactors, stability of non-isothermal reactors, optimal reactor performance and radical polymerization. *Prep. Thermodynamics, undergraduate Chemical Engineering Kinetics or equivalent.*

Offered yearly, winter quarter

4.891 Selected Topics in Kinetics of Chemical Processes (4 q.h. credits)

Theoretical foundations are developed for the investigation and rationalization of chemical reaction rates. Rate theories regarding elementary steps; sequential reactions using the steady-state approximation; correlations of homogeneous and heterogeneous catalysis; matrix methods applied to the analysis of reaction networks. *Prep. Undergraduate Thermodynamics.*

Offered yearly, fall quarter

4.899 Special Topics in Chemical Engineering (4 q.h. credits)

Topics of interest to the staff member conducting this class are presented for advanced study. A student may not take more than one Special Topics course with any one instructor. *Prep. Permission of department staff.*

Offered yearly, all quarters

4.973 Special Topics in Chemical Process Heat Transfer (4 q.h. credits)

Empirical methods and calculations used to design heat transfer equipment for the chemical process industries. Review of basic heat transfer principles. Shell-and-tube calculations for liquid and/or vapor phase heat transfer. Direct contact and other special heat exchanger applications. *Prep. Undergraduate Heat Transfer.*

4.974 Selected Topics in Fluid Mechanics (4 q.h. credits)

Discussion of statics, kinematics, and stress concepts associated with fluids. Formulation of the general equations of motion with application to laminar and turbulent flow. Topics on boundary layer theory and compressible flow are included. *Prep. Undergraduate Fluid Mechanics.*

Offered yearly, winter quarter

4.990 Seminar

Topics of an advanced nature are presented by staff, outside speakers, and students in the graduate program. This course must be attended by all master's degree candidates. *Prep. Admission to graduate program in Chemical Engineering.*

Offered yearly, all quarters

4.991 Thesis (Master's Degree)

Analytical and/or experimental work conducted under the supervision of the department. For master's degree requirement. *Prep. Admission to Master of Science program in Chemical Engineering.*

Offered yearly, all quarters

4.995 Thesis (Ph.D. Degree)

Theoretical and experimental work conducted under the supervision of the department. *Prep. Admission to doctoral program in Chemical Engineering.*

Offered yearly, all quarters

4.996 Thesis (D. Eng. Degree)

Theoretical and experimental work conducted under the supervision of the department. *Prep. Admission to doctoral program in Chemical Engineering.*

Offered yearly, all quarters

INDUSTRIAL ENGINEERING AND ENGINEERING MANAGEMENT

5.801 Analysis of the Industrial Enterprise I

A background for the practicing engineer, covering the various phases of operation within the industrial enterprise; history and growth; management selection and development; labor-management relations; product development and marketing; public relations and the corporate image. *Prep. Bachelor of Science degree in Engineering or Science.*

Offered yearly, all quarters

5.802 Analysis of the Industrial Enterprise II

The environment in which the industrial enterprise operates; modern planning and forecasting; meeting the technological advance; financial aspects within and without the company; the effect of the economic climate; community and government influences. *Prep. 5.801 Analysis of the Industrial Enterprise I.*

Offered yearly, all quarters

5.803 Industrial Organizations

An analysis of the purpose and functioning of organizations as the basic networks for goal satisfaction through coordination of effort, communication, and responsibility. The approach will be based on modern behavioral science concepts. *Prep. Admission to Program.*

Offered yearly, days only, fall quarter

5.805 Industrial Budgeting for Engineers

Budgeting plans, programs, and reports for industry today; an introduction to

the essentials of fixed and variable budgeting for production, inventory, sales, cash, capital, and cost-volume-profit analysis. *Prep. 5.810, Industrial Accounting or equivalent.*
Offered yearly, fall quarter

5.806 Production Forecasting

Econometric methods of forecasting the demand for industrial products; emphasis on techniques applicable to individual companies and the total demand. The principal tool used is the mathematical model of the causal factors with special attention to determining the reliability of the model. *Prep. 5.951, Engineering Statistics II or equivalent.*
Offered yearly, fall quarter

5.808 Basic Engineering Economy

Economic analysis in formulating business policies and selecting alternatives from possible engineering solutions to industrial problems, present worth, annual cost, and rate of return techniques with continuous and discrete interest calculations. *Prep. Bachelor of Science degree in Engineering or Science.*
Offered yearly, all quarters

5.809 Advanced Engineering Economy

Principal emphasis on the practical application of the techniques studied in basic engineering economy; problems of implementation through class discussion of cases and a major term project; recent advances in the techniques of engineering economy, especially those relating to the consideration of uncertainties. *Prep. 5.808, Basic Engineering Economy or equivalent.*
Offered yearly, fall and winter quarters

5.810 Industrial Accounting for Engineers

Introduction of basic accounting principles and procedures; use of accounting data as a management tool; a practical coverage of basic cost procedures related to materials, labor, and manufacturing expense cost control; job order, process, and standard cost systems. *Prep. Bachelor of Science degree in Engineering or Science.*
Offered yearly, all quarters

5.811 Cost Accounting for Engineers

Cost accounting procedures as established by accountants are studied and evaluated in terms of being considered by the engineer for cost determination of alternative engineering proposals. *Prep. 5.810, Industrial Accounting or equivalent.*
Offered yearly, winter quarter

5.812 Management of Technical Innovation

Analysis of the particular problems of managing research, development and engineering based on current developments in general management theory and the behavioral sciences; technical innovation as part of the overall organization; class discussion of cases and student term papers. *Prep. Bachelor of Science degree in Engineering or Science.*
Offered yearly, fall and winter quarters

5.813 Engineering Communication

Exploration of practice in the effective preparation and presentation both written and oral, of the results of engineering projects and programs as a basis for business decisions: including formal reports, progress summaries, memoranda, and technical papers. The effective use of various media and audio visual aids based on both audience and material. Consideration of the types of audiences frequency encountered and their needs and reactions as factors in selecting approach.

5.814 Development of Engineering Managers

Analysis of the problems faced by the engineer in the transition from individual contributor to engineering manager; the challenge of engineering management; analyzing what is their business and who are their customers; integrating profession and management objectives; developing guides for engineering managers, enabling them to examine their own work and performance, to diagnose their weaknesses, and to improve their effectiveness as well as the results of the enterprise. *Prep. 5.801, Analysis of the Industrial Enterprise I.*

Offered yearly, all quarters

5.815 Legal Aspects of New Technology

The relationship of laws and regulations to technical innovation and related corporate activities; emphasis on the patent and copyright systems; trade secrets; managing intellectual property as part of employer-employee relations; disposition of rights under federal contracts and grants. *Prep. Bachelor of Science degree in Engineering or Science.*

Offered yearly, fall and spring quarters

5.816 Industrial Psychology for Engineers

A general coverage of the application of psychology to industry with emphasis on industrial environments and organization, human relations, group dynamics, tests and measurements, personnel practices, training, and motivation. *Prep. Bachelor of Science degree in Engineering or Science.*

Offered yearly, all quarters

5.817 Advanced Work Design

Basic philosophies of work design; implementation of work design concepts with case studies; study and analysis of models such as work sampling, sequence or flow of work models; repetitive and nonrepetitive work models, and work measurement models such as standard data; human factors in measuring operator performance; regression analysis approaches; emphasis on development of professional, analytical, and managerial skills and abilities at a systems level. *Prep. Bachelor of Science degree in Engineering or Science.*

Offered yearly, spring quarter

5.819 Human Factors in Man-Machine Systems

Design of equipment and systems for human use; emphasis on the application of engineering psychology; visual and auditory presentation of information — speech communications, man-machine dynamics, design of controls, layout of work places, and environmental effects on human performance. *Prep. Bachelor of Science degree in Engineering or Science.*

Offered yearly, all quarters

5.820 Personnel Administration for Engineers

Personnel programs for attracting and retaining technical talent; evaluating effectiveness of major personnel policies; modern methods of salary and wage administration; planning profitable relationships among company, supervisors, and employees. *Prep. Bachelor of Science degree in Engineering or Science.*

Offered yearly, winter and spring quarters

5.822 Product Design and Value Analysis

Study of design parameters and their effect on development, manufacturing and procurement; functional analysis of components and systems; complete projects and case studies are integrated in the course. *Prep. Bachelor of Science degree in Engineering or Science.*

Offered yearly, winter and spring quarters

5.823 Advanced Production Analysis (4 q.h. credits)

Study of advanced problem-solving techniques in the areas of method and measurement, layout and facilities planning, material handling and manufacturing processes. Case studies and a course project in a local concern illustrate the concepts presented. *Prep. Bachelor of Science degree in Engineering or Science.*
Offered yearly, days only, fall quarter

5.824 Case Studies in Industrial Engineering

Formulation of problems and analysis of situations on topics such as: work measurement, line balancing, plant layout, regression analysis, wage and salary administration, management information systems and network analysis. Class discussion and written analysis of a variety of cases is included. *Prep. 5.823, Advanced Production Analysis.*
Offered yearly, days only, spring quarter

5.825 Topics in Production Engineering

Production problems to include: line balancing, plant location, plant layout and material handling, design of manufacturing systems, job sequencing. Course utilizes readings, projects and case studies. (Not open to those who have taken 5.823, Advanced Production Analysis) *Prep. Bachelor of Science degree in Engineering or Science.*
Offered yearly, winter quarter

5.830 Financial Management I

Study of the issues and processes of short-term financing of industrial firms; financial analysis of cases, supplemented by readings to develop familiarity with sources and uses of working capital as well as the goals and problems involved in its management. (Open to Engineering Management majors only.) *Prep. 5.801, Analysis of the Industrial Enterprise I, and 5.810, Industrial Accounting for Engineers, and 5.808, Basic Engineering Economy or equivalent.*

Offered yearly, all quarters

5.831 Financial Management II

Extension of Financial Management I with emphasis on analysis necessary to such long-term financial decisions as issuance of stock or bonds; contracting of leases or loans, and financing of a new enterprise; mergers, capital budgeting, the cost of capital, and the valuation of a business. *Prep. 5.830, Financial Management I.*

Offered yearly, all quarters

5.840 Seminar on Management of Engineers

Each student will prepare a term project on a subject of his choosing to be presented orally and in writing; discussions of major problem areas led by instructor and guest speakers. (Limited to 15 students selected from preregistration applications.) *Prep. 5.812 or 5.814 or 5.816 or 5.820.*

Offered yearly, spring quarter

5.841 Engineering Project Administration

Study of the problems of coordinating human, technical, and financial resources for initiating, conducting, and completing major technical projects; planning, organizing, staffing, directing, and controlling using modern concepts and techniques; scheduling, budgeting, communicating; coping with uncertainty and probability; analysis of typical cases. *Prep. Bachelor of Science degree in Engineering or Science.*

Offered yearly, fall and spring quarters

5.860 Health Care Organization and Management

History of the development and the delivery of health services; health organiza-

tion functions and inter-relationships of health-oriented organizations; study of certain legal principles and rulings of importance to medical personnel; introduction to interpersonal ethics of patient care. *Prep. Admission to the Graduate School of Engineering.* Offered yearly, fall quarter

5.862 Introduction to Occupational Health and Safety

Accident prevention, accident cost analysis, Federal and local legislation, record keeping requirements under OSHA Act of 1970; occupational safety and health standards, safety programs and inspections, fire prevention and control methods; human behavior and industrial safety, occupational diseases and personnel protective equipment. *Prep. Bachelor of Science degree in Engineering or Science.* Offered yearly, fall quarter

5.863 Technical Aspects of Health and Safety

Safety responsibilities of management and employees; methods of hazard control; accident investigation; recognition of chemical, electrical and mechanical hazards; principles of machine guarding; occupational safety and health standards, safety training; toxicology and first aid and medical services. *Prep. 5.862, Introduction to Occupational Health and Safety or permission of the instructor.*

Offered yearly, winter quarter

5.864 Topics in Physiology and Biomedical Engineering

Introduction to specific areas relating to human structure and function, and to the use of engineering techniques for medical diagnosis and therapy. Areas considered include blood and blood components, the cardiovascular system, the kidney and urinary systems and respiratory systems. The course will be taught on a seminar basis. Students will be required to do literature research under the guidance of the instructor. *Prep. permission of instructor.*

Offered yearly, spring quarter

5.865 Case Studies in Health Systems

Readings and discussion of case histories of application of systems analysis to field of health. Outstanding administrators and systems analysts from various health organizations will be invited to speak to class. *Prep. Admission to the Graduate School of Engineering.*

Offered yearly, spring quarter

5.900 Basic Operations Research (4 q.h. credits)

An introduction to the theory and use of deterministic and stochastic models to represent industrial operations. Models included are those of linear programming, dynamic programming, inventory control, waiting lines, and Monte Carlo simulation. Embodies the material in 5.901 and 5.902, Basic Operations Research I and II. Open to both day and evening students. *Prep. 5.951, Engineering Statistics II or 10.8G1, Probability.*

Offered yearly, fall quarter

5.901 Basic Operations Research I

Introduction to the theory and use of deterministic models to represent industrial operations; includes linear programming, dynamic programming, networks, and game theory. *Prep. Bachelor of Science degree in Engineering or Science.*

Offered yearly, all quarters

5.902 Basic Operations Research II

Introduction to the theory and use of stochastic models to represent industrial operations; includes queuing, inventory, and Markovian models. *Prep. 5.901, Basic Operations Research I and 5.951, Engineering Statistics II or equivalent.*

Offered yearly, all quarters

5.903 Inventory Control and Production Planning

The design and operation of inventory systems from a scientific management point of view, including both required theory and practical aspects. Subjects include inventory control models, statistical forecasting, production scheduling techniques, distribution systems, management control and reports, discussion of actual systems, and a case study. *Prep. 5.951, Engineering Statistics II or equivalent.*

Offered yearly, spring quarter

5.904 Queuing Theory and Its Applications

A development of the theory of queues using the equations of detailed balance approach; study of models based on random arrivals including exponential and Erlang service distributions, single and multiple services, series and parallel systems, and finite and infinite queues, applications to staffing, inventory control, maintenance, and scheduling. *Prep. 5.900 or 5.902, Basic Operations Research*

Offered yearly, winter quarter

5.905 Analysis with Simulation

Model building for digital simulation, testing and validation of models, simulation compiler languages, logic flow charting, applications drawn from economics, scheduling, inventory problems, marketing, and others; programming and running of several models. *Prep. 5.913, Data Processing for Engineers and 5.951, Engineering Statistics II or equivalent.*

Offered yearly, winter quarter

5.906 Principles of Dynamic Systems I

Introduction to modeling of social systems, emphasizing the study of feedback structures and their behavior; development of concepts that allow one to understand the mechanisms underlying growth, stagnation and cyclical fluctuation; examples and practice at formulating models of industrial, economic, social, and ecological systems; study of some of the effects of delays, multiple feedback loops, and non-linearities; aim to building an intuitive foundation for simulation studies of complex systems. *Prep. Bachelor of Science degree in Engineering or Science.*

Offered yearly, fall quarter

5.907 Principles of Dynamic Systems II

Continuation of topics from 5.906 with increased experience in the construction and analysis of generic feedback structures; examination of current and previous System Dynamics applications including Urban Dynamics and World Dynamics; exercises in model conceptualization. *Prep. 5.906, Principles of Dynamic Systems I.*

Offered yearly, winter quarter

5.908 Principles of Dynamic Systems III

Treatment of the process and problems of application and implementation of System Dynamics. Individual student modeling projects using System Dynamics. *Prep. 5.907, Principles of Dynamic Systems II.*

Offered yearly, spring quarter

5.909 Systems Engineering and Analysis

Methods of describing, analyzing, and manipulating complex systems both open and closed loop; meaning of system optimization; classical optimization techniques; emphasis on the description and design of a system rather than system manipulation and on "complete" system rather than submanipulation; examples drawn from transportation, information, manufacturing, etc. *Prep. Admission to the Program.*

Offered yearly, days only, winter quarter

5.910 Analytical Techniques for Engineers

Linear algebra, transform techniques including Laplace transforms and z transform; systems of linear differential equations. *Prep. Bachelor of Science degree in Engineering or Science.* Offered yearly, fall quarter

5.911 Linear Programming

Covers in-depth techniques and theory contained in linear, quadratic, and non-linear programming which would include sensitivity analysis, the dual theorem, parametric programming, and problems involving uncertainty. *Prep. 5.900 or 5.902, Basic Operations Research or equivalent and a course in linear algebra.*

Offered yearly, spring quarter

5.912 Network Planning and Control

Applications of the theory of flow through networks to scheduling, planning, line balancing, transportation, and materials handling; PERT and Critical Path Scheduling; case studies of successful and unsuccessful applications; computer and manual solutions utilized. *Prep. 5.913, Data Processing for Engineers or equivalent.*

Offered yearly, spring quarter

5.913 Data Processing for Engineers

Open only to students who have not had a basic course or extensive experience in a compiler language. A study of digital computers and computer programming techniques as applied to management problems. The course will cover the basic characteristics and operation of computing equipment and peripheral devices. The FORTRAN language is presented in depth and will be utilized by the student for programming and running several projects on a computer. Other compiler languages will be described and compared to FORTRAN. A systems approach to the design, development, and implementation of computer programs for solving management problems will be emphasized. Examples will be studied from several management areas. *Prep. Bachelor of Science degree in Engineering or Science.*

Offered yearly, all quarters

5.914 Advanced Operations Research (4 q.h. credits)

Further study of quantitative techniques available to assist management in scientific decision-making, including Markov processes, utility theory, Bayesian statistics, and forecasting; case studies of real industrial problems. *Prep. 5.900, Basic Operations Research.*

Offered yearly, days only, spring quarter

5.916 Engineering Analysis Utilizing Data Processing

Engineering and quantitative management problems utilizing medium to large data processing systems; application areas include simulation and file management; the principles of modern operating systems are discussed in detail. *Prep. 5.913 or equiv.*

Offered yearly, fall quarter

5.930 Basic Computer Systems Technology

Introduction to computer systems and assembly language programming. Topics include: machine language, assemblers, and compilers. Input/output device control. List processing, searching, and sorting; file systems and storage management. Students are required to prepare and test several programs. The emphasis is on basic concepts necessary to understand and evaluate technological development. *Prep. 5.913.*

Offered yearly, fall and winter quarters

5.931 Computer Systems

Introduction to hardwares and software packages, on-line real-time computer

systems, and time-sharing and resource allocation. Telecommunications. Graphics terminals and data collection devices are also discussed. The course seeks to develop the student's understanding of computer technology so that he can successfully employ it in new and creative ways. *Prep. 5.930.*

Offered yearly, winter and spring quarters

5.932 Advanced Computer Systems

Topics in the forefront of the computer software field. Discussion of the design choices in Advanced Computer Systems raises the major design and operating issues concerning digital computers. *Prep. 5.931.* Not offered 1974-75

5.940 Basic Information System Technology

Introduction to the concepts which support the field of information systems. Introduction to hardware and software systems and structuring problems in computer terms. Both lectures and cases are used to illustrate basic issues which include hardware components and their relative speeds, methods for balancing systems components, models of machines and concepts underlying application programs, translators, utilities, and operation systems. Data structures and data management are treated from the viewpoint of optimizing systems design for large scale data bases. *Prep. Bachelor of Science degree in Engineering or Science and 5.913.*

Offered yearly, fall and winter

5.941 Management Information Systems

The development of a framework which emphasizes support to management decision making. Theoretical and pragmatic considerations are used as a base from which a final framework is developed. This framework is applied to the design, installation, and evaluation of traditional management information systems (formerly 5.818). *Prep. Bachelor of Science degree for Engineering or Science.*

Offered yearly, all quarters

5.942 Advanced Management Information Systems

Designed to provide greater depth and some practical exposure to the issues and concepts raised in Management Information Systems. Topics will include design models for modular systems with emphasis on on-line, real-time systems and project planning and control. *Prep. 5.940, 5.941.*

Offered yearly, spring quarters

5.943 Management Decision Systems

Seminar course exploring the design issues involved in building management decision systems. Includes methods of making explicit the manager's decision processes, as well as the design process for building effective man/machine systems. *Prep. 5.940, 5.941.*

Not offered in 1974-75

5.950 Engineering Statistics I

A brief though rigorous introduction to probability as foundation for statistics; discrete and continuous distributions such as the binomial, Poisson, hypergeometric and normal; mean and variance; operations research; sampling distributions. *Prep. Bachelor of Science degree in Engineering or Science.*

Offered yearly, all quarters

5.951 Engineering Statistics II

An introduction to the techniques of statistical inference, treatment of statistical data, inferences concerning means, variances and proportions, regression

analysis, correlation and other statistical concepts. *Prep. 5.950, Engineering Statistics I or 10.8G1, Probability or equivalent.* Offered yearly, all quarters

5.952 Design of Experiments I

An introduction to experimental design and analysis; modeling for fixed, random and mixed factor designs such as: single factor, randomized blocks, Latin square and factorial experiments, analysis of variance and covariance, orthogonal contrasts. *Prep. 5.951, Engineering Statistics II or 10.9H1, Mathematical Statistics or equivalent.* Offered yearly, fall quarter

5.953 Statistical Decision Theory

Use of Bayesian statistical inference to arrive at decisions when stochastic variables are interacting; relationship to game theory; decision making over time in a sequence; important expected values and distributions; relationship of Bayesian decision theory to classical statistical inference. *Prep. 5.950, Engineering Statistics I or 10.8G1, Probability or equivalent.*

Offered yearly, fall quarter

5.954 Advanced Quality Control

Economics of quality, specification of quality, organization for quality, statistical methods of quality control; quality policies and objectives; personnel methods for quality; design of testing and inspection procedures; budgeting of quality programs; sampling by variables, sampling for life testing, continuous sampling. *Prep. 5.951, Engineering Statistics II or equivalent.*

Offered yearly, winter quarter

5.955 Reliability and Maintainability Applications

An introduction to reliability and maintainability engineering technology applied to system and circuit design; the "bath-tub" curve; stress de-rating of components; failure rate and repair rate prediction techniques and assessment; early failure, useful life, and wearout characteristics. *Prep. 5.951, Engineering Statistics II or equivalent.*

Offered yearly, fall quarter

5.956 Mathematical Theory of Reliability

Probability mathematical techniques utilized in systems reliability analysis; prediction; allocation and demonstration testing; reliability probability functions, active and standby redundancy with or without repair, spares planning, and availability. *Prep. 5.955, Reliability and Maintainability Applications.*

Offered yearly, winter quarter

5.957 Designing for Reliability

Oriented to the design of electronic systems; development of complex system reliability mathematical models; Markovian chain stochastic processes, matrix algebra applied to redundancy problems; flow-diagram techniques using Laplacian transforms, and queuing theory for repairable systems; system-effectiveness methods particularly those developed by Hunter and Barlow. *Prep. 5.955, Reliability and Maintainability Applications.*

Offered yearly, spring quarter

5.958 Design of Experiments II

Further design considerations in experimental design and analysis such as: nesting, split-plot, factorial confounding, fractional factorial, response surfaces. Computer applications to design analysis. *Prep. 5.952, Design of Experiments I or equivalent.*

Offered yearly, spring quarter

5.991 Thesis (Master's Degree) (6 q.h. credits)

Analytical and/or experimental work conducted under the auspices of the department. *Prep. Consent of adviser.* Offered yearly, all quarters

5.992 Seminar in Industrial Engineering

Discussion and presentations of thesis related topics by students, presentations and discussions by faculty and eminent people in the field on timely industrial engineering topics. Field trips and visitations included where appropriate.

Offered yearly, days only, fall quarter

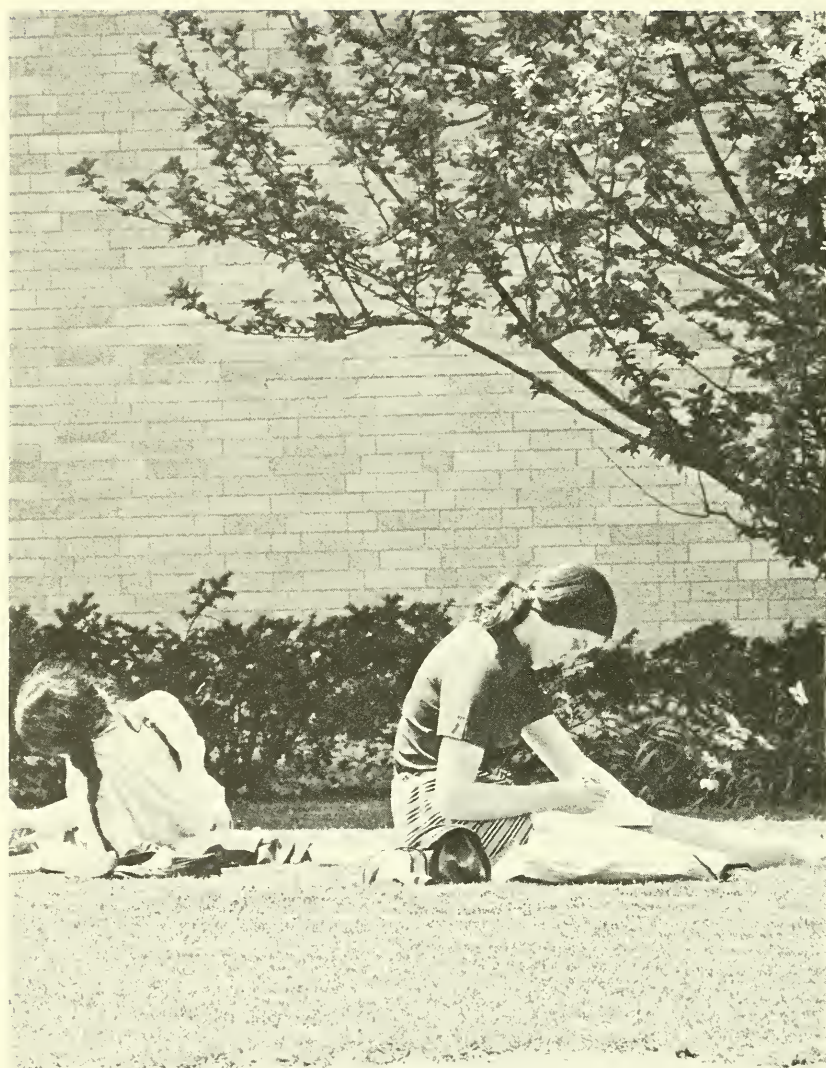
5.993 Special Problems in Industrial Engineering

Individual work under faculty supervision. *Prep. Consent of adviser.*

Offered yearly, all quarters

mathematics and physics

For mathematics and physics courses consult the bulletin of the Graduate School of Arts and Sciences.



index

A

- Academic calendar, 5
- Academic Council, 13
- Address of University, 1
- Administration
 - University, 11-13
 - Graduate Division, 14
- Admission
 - Doctor's degree, 33
 - Master's degree, 31
- Appointments to fellowships, assistantships, 32, 44, 45

B

- Board of Trustees, 9
- Buildings, 21-23

C

- Calendar, 5
- Campus description and location, 21
- Campus map, 4
- Center for Continuing Education, 20
- Chemical Engineering, 83
- Civil Engineering, 51
- Class hours, 30
- Colleges (undergraduate), 159
- Committee on Graduate Study in Engineering, 18
- Cooperative Plan of Education (see also fields of study), 33
- Corporation members, 7, 8
- Courses, Description of
 - Chemical Engineering, 142
 - Civil Engineering, 97
 - Electrical Engineering, 121

- Industrial Engineering and Engineering Management, 146
- Mathematics and physics, 155
- Mechanical Engineering, 108

D

- Degree programs, 28, 31, 33, 36, 40 (see also fields of study)
- Doctor's degrees (see also fields of study)
 - Admission, 34
 - Classification, 34
 - Comprehensive examination, 34
 - Course requirements, 34
 - Degree candidacy, 34
 - Dissertation, 35
 - Doctor of Engineering Degree, 36
 - Final oral examination, 35
 - Language requirement, 35
 - Interdisciplinary programs, 38
 - Qualifying examination, 34, 37
 - Registration, 36, 38
 - Residence requirement, 36
 - Time limitation, 35, 38
 - Transfer credit, 35, 38

E

- Engineer Degree, 40
- Electrical Engineering, 69
- Engineering Management, 92
- Executive Council, 13

F

- Faculty, 47
- Faculty Senate, 14
- Fees, 43
- Fellowships, 44, 45
 - Appointments to, 45
 - Doctoral research, 45
 - Graduate cooperative research, 45
 - Research, 45
- Fields of study
 - Chemical Engineering, 83
 - Civil Engineering, 51
 - Electrical Engineering, 69
 - Industrial Engineering and Engineering Management, 89
 - Mathematics and Physics, 155
 - Mechanical Engineering, 60
- Financial Information, 43

G

- Grading System, 29
- Graduate and Professional Schools, 19, 20
- Graduate School of Engineering
 - Fields of study, 51
 - Registration, 28
 - Regulations, 25

H

- Henderson House, 23

I

- Industrial Engineering and Engineering Management, 89
- Interdisciplinary programs, 38, 39
 - Admission, 39
 - Interdisciplinary Committee, 39

L

- Loan program, 45

M

- Map of campus, 4
- Marine Science Institute, 23

- Master's degree (see also fields of study)

- Academic classification, 31
- Admission, 31
- Comprehensive examination, 32
- Thesis, 32
- Time limitations, 32
- Transfer credits, 32

- Mathematics, 155

- Mechanical Engineering, 60

N

- Nashua Campus, 23
- NDEA Loan Program, 45

P

- Part-time programs (see also fields of study), 33
- Physics, 155
- Programs of study (see also fields of study), 28

R

- Registration dates, 5, 6
- Regulations
 - For doctor's degree, 33
 - For master's degree, 31
 - Graduate division, 25
- Research activities, 20
- Research fellowships, 45

S

- Suburban Campus, 22

T

- Tuition, 43
- Trustees, 9

U

- Undergraduate colleges, 159
- University Council, 13
- University Graduate Council, 15

W

- Warren Center, 23
- Withdrawals, 30

UNDERGRADUATE COLLEGES

Full-time day curricula on the Cooperative Plan leading to baccalaureate degrees are offered by:

Boston-Bouvé College
College of Business Administration
College of Criminal Justice
College of Education
College of Engineering
College of Liberal Arts
College of Nursing
College of Pharmacy and Allied Health Professions
Lincoln College

Part-time curricula during late afternoon and evening hours leading to associate and baccalaureate degrees are offered by:

Lincoln College
University College



northeastern university bulletin



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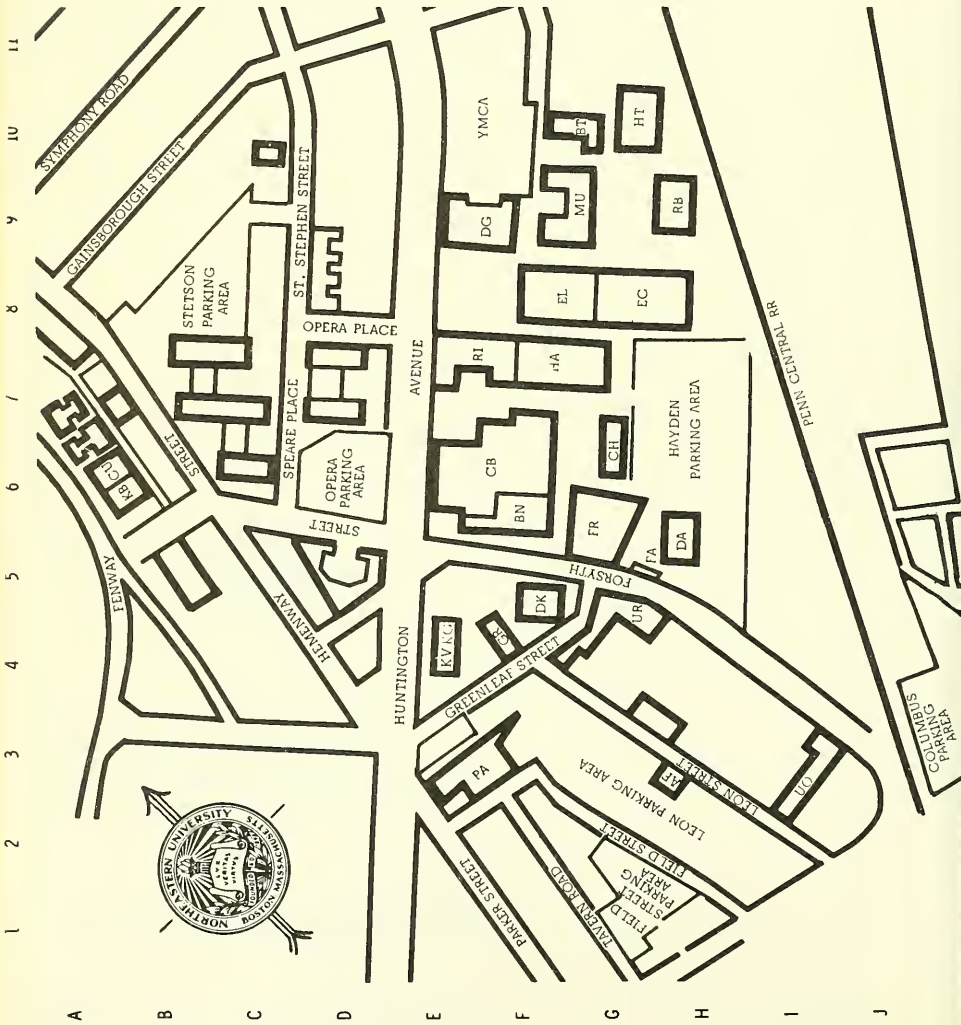


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Graduate School of Arts and Sciences 1974-76



**MAP
REFERENCE**

- F6
- F10
- E6
- G7
- A6
- H6
- F5
- E9
- G8
- F8
- G6
- G5
- F4
- F7
- G10
- B6
- E4
- E4
- J3
- H3
- F9
- F3
- E7
- H9
- G5

**Building
Designation**

- BN
- BT
- CB
- CH
- CU
- DA
- DK
- DG
- EC
- EL
- FR
- FA
- GR
- HA
- HT
- KB
- KV
- KG
- UO
- AF
- MU
- PA
- RI
- RB
- UR

Building

- Bartletta Natatorium
- Botolph Building
- Cabot Physical Education Ctr.
- Churchill Hall
- Cushing Hall
- Dana Research Center
- Dockser Hall
- Dodge Library
- Ell Student Center and Alumni Auditorium
- Forsyth Building
- Forsyth Building Annex
- Greenleaf Building
- Hayden Hall
- Hurtig Hall
- Kennedy Building
- Knowles Center (Volpe)
- Knowles Center (Gryzmish)
- 11 Leon Street
- Afro-American Institute
- Mugar Life Sciences Building
- Parker Building
- Richards Hall
- Robinson Hall
- United Realty Building

contents

2	Campus Map
4	Academic Calendar
5	The Governing Boards and Officers of the University
5	The Northeastern University Corporation
7	Board of Trustees
8	Administration Organization
10	General University Committees
11	Organization of the Graduate Schools
15	The University
17	Buildings and Facilities
19	The Graduate School of Arts and Sciences
19	General Regulations
23	The Master's Degree
24	The Doctor of Philosophy Degree
26	Interdisciplinary Programs
28	Financial Information
28	Financial Obligations
29	Financial Aid
32	Fields of Study
32	Biology
44	Chemistry
51	Clinical Chemistry
55	Economics
65	English
74	History
82	Mathematics
93	Physics
101	Political Science
112	Psychology
117	Sociology and Anthropology
127	Index
128	Departmental Directory

ACADEMIC CALENDAR 1974-1975

Fall Quarter 1974

Registration period		
Boston	Monday-Thursday	Sept. 23-26
Classes begin	Monday	Sept. 30
Examination period	Monday-Saturday	Dec. 16-21

Winter Quarter 1974-1975

Registration period		
Boston	Monday-Thursday	Dec. 9-12
Classes begin	Monday	Jan. 6
Examination period	Monday-Saturday	Mar. 24-29

Spring Quarter 1975

Registration period		
Boston	Monday-Thursday	Mar. 17-20
Classes begin	Monday	April 7
Last day to file commencement card for Spring Commencement	Tuesday	April 1
Last day to pay fee for Spring Commencement	Wednesday	April 30
Final grades due in Registrar's Office for June graduates taking third quarter course	Friday	June 6
Examination period	Monday-Saturday	June 16-21
Spring Commencement	Sunday	June 22

Summer Quarter 1975

Registration period		
Boston	Wednesday-Thursday	June 18-19
Classes begin	Monday	June 30
Last day to file commencement card for Fall Commencement	Tuesday	July 1
Last day to pay fee for Fall Commencement	Friday	August 1
Examination period	Wednesday-Saturday	Aug. 6-9

UNIVERSITY HOLIDAYS 1974-1975

Columbus Day	Monday	October 14
Veterans' Day	Monday	October 28
Thanksgiving Recess	Thursday-Saturday	Nov. 28-30
Christmas Vacation	Monday-Saturday	Dec. 23-Jan. 4
Washington's Birthday	Monday	February 17
Patriot's Day	Monday	April 21
Memorial Day	Monday	May 26
Independence Day	Friday	July 4
Labor Day	Monday	September 1

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1974-1975

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the university

Founded in 1898, Northeastern University is incorporated as a privately endowed nonsectarian institution of higher learning under the General Laws of Massachusetts. The State Legislature by special enactment has given the University general degree-granting powers. The University is governed by a Board of Trustees elected by and from the Northeastern University Corporation, which is composed of nearly 180 distinguished business and professional men and women.

From its beginning, Northeastern University has had as its dominant purpose the discovery of community educational needs and the meeting of these in distinctive and serviceable ways. The University has not duplicated the programs of other institutions, but has sought to pioneer new areas of educational service.

A distinctive feature of Northeastern University is its Cooperative Plan, initiated by the College of Engineering in 1909 and subsequently adopted by the Colleges of Business Administration (1922), Liberal Arts (1935), Education (1953), Pharmacy (1962), Nursing (1964); Boston-Bouvé College (1964); the College of Criminal Justice (1967), and by Lincoln College's day Bachelor of Engineering Technology Programs (1971). This educational method enables students to gain valuable practical experience as an integral part of their college program and also provides the means by which they may contribute substantially to the financing of their education. The Plan has been extended to the graduate level in engineering, actuarial science, rehabilitation administration, professional accounting, business administration, and law.

In the field of adult education, programs of study have been developed to meet a variety of needs. University College offers evening courses — offered by the University since 1906 — and adult-day courses leading to the bachelor's degree. In addition to its day undergraduate programs in Electrical Engineering Technology and Mechanical Engineering Technology, Lincoln College offers evening/part-time certificate, associate, and bachelor degree programs in technological areas. All formal courses of study leading to degrees through part-time programs are approved by the Basic College faculties concerned.

GRADUATE AND PROFESSIONAL SCHOOLS

The ten graduate and professional schools of the University offer day and evening programs leading to the degrees listed:

The Graduate School of Actuarial Science offers the degree of Master of Science in Actuarial Science.

The Graduate School of Arts and Sciences offers the degrees of Master of Arts, Master of Science, Master of Science in Health Science, Master of Public Administration, and Doctor of Philosophy.

The Graduate School of Boston Bouvé College offers the degree of Master of Science, with specialization in Physical Education and Recreation Education.

The Graduate School of Business Administration offers the degree of Master of Business Administration.

The Graduate Program in Criminal Justice offers the degree of Master of Science.

The Graduate School of Education offers the degree of Master of Education and the Certificate of Advanced Graduate Study.

The Graduate School of Engineering offers the degrees of Master of Science, Engineer, Doctor of Philosophy, and Doctor of Engineering in Chemical Engineering.

The School of Law offers the degree of Juris Doctor.

The Graduate School of Pharmacy and Allied Health Professions offers the degrees of Master of Science and Doctor of Philosophy.

The Graduate School of Professional Accounting offers the degree of Master of Science in Accounting.

CENTER FOR CONTINUING EDUCATION

The Center for Continuing Education was established to relate the University to the needs of its community in a period of accelerated change. Its programs are composed of seminars, conferences, institutes, forums, and a wide variety of special courses designed to serve specific needs. The Division of Special Programs, working cooperatively with trade associations and professional societies, offers a wide variety of programs dealing with current needs and problems. Through its Division of Community Services, working with governmental agencies and community organizations, the Center is becoming increasingly involved in social problems on both the local and national level.

Many of these programs are conducted at Henderson House, Northeastern University's conference center in Weston, Massachusetts.

RESEARCH ACTIVITIES

The facilities of the University are engaged in a wide variety of basic research projects in business, science, social science, pharmacy, and engineering. These are conducted by the Dean of Research, whose services are University-wide and available to the faculties of all the Colleges.

Although Northeastern is primarily concerned with undergraduate and graduate instruction, the University believes that the most effective teaching and learning takes place in an environment characterized by research activities directed toward extending the frontiers of knowledge.

buildings and facilities

MAIN CAMPUS

The main campus of Northeastern University is located at 360 Huntington Avenue in the Back Bay section of Boston. Many of the city's famous cultural, educational, and philanthropic institutions are situated in the Back Bay, including the Museum of Fine Arts, Symphony Hall, Horticultural Hall, the Isabella Stewart Gardner Museum, the Harvard teaching hospitals, the Boston Public Library, and many schools and colleges. Most are within walking distance of Northeastern University.

Major transportation facilities serving the Boston area are Logan International Airport, two rail terminals, bus terminals serving inter- and intrastate lines, and MBTA subway-bus service within the metropolitan-suburban area. There is a subway stop in front of the campus. For motorists, the best routes to the campus are the Massachusetts Turnpike (Exit 22) and Route 9, of which Huntington Avenue is the intown section.

The campus of 48 acres is divided by Huntington Avenue, with the main educational buildings on one side and dormitories on the other. The principal buildings, all of which have been constructed since 1938, are of glazed brick in contemporary classic style. Most are interconnected by underground passageways.

Libraries

The University library system consists of the Dodge Library, which is the main library; the Suburban Campus Library at Burlington; the School of Law Library; and three divisional libraries for Physics and Electrical Engineering, Chemistry and Biology, and Mathematics and Psychology, Physical and Recreation Education, and Physical Therapy. There are additional subject collections for the Center of Management Development at Andover, Massachusetts, and the Marine Science Institute at Nahant.

The library collections number 360,000 volumes supplemented by some 267,000 titles in microprint, microfilm, and microfiche forms. The collection includes, in addition, some 3,500 periodical titles, 90,000 documents, and 4,600 sound recordings.

Apartments for Graduate Students

The University maintains a 100-apartment housing unit which accommodates 279 people. Two-, three-, and four-party apartments are available which vary in size from two to four rooms plus bath. Apartments are furnished with beds, chairs, desks, stove, refrigerator, and kitchen table. The cost includes all utilities.

A \$50 deposit is required when making application for the apartments. Applications are available in the Office of University Housing. Students are expected to make such arrangements on a term-to-term basis but may live in the apartments both while on cooperative work assignments and in school if they wish. All reservations are made on a first come, first served basis.

SUBURBAN FACILITIES

Suburban Campus

The Suburban Campus, located near the junction of Routes 128 and 3 in Burlington, Massachusetts, was established to meet the needs of individuals and of industry in the area.

In addition to graduate courses in engineering, business administration, science, education, and the arts, portions of undergraduate programs leading to the associate and bachelor's degrees, special programs for adults, and noncredit state-of-the-art programs are offered.

Marine Science Institute

The Marine Science Institute at Nahant, Massachusetts, is a research and instructional facility primarily engaged in studies of marine biology and oceanography. The Institute is operated all year, and is about 20 miles northeast of Boston. Many of the courses at the institute are applicable toward an advanced degree in biology or health science.

Government Center Campus

With the cooperation of the Federal Executive Board, the Department of Political Science offers an entire Master of Public Administration Program at the John F. Kennedy Building in downtown Boston. This program is primarily for individuals employed in federal, state, or local civil services.

the graduate school of arts and sciences

Thirty years ago the Department of Chemistry and the Department of Physics inaugurated the first graduate programs at Northeastern. In the succeeding years the creation of degree programs in other departments of the College of Liberal Arts led to the formation of the graduate program of arts and sciences in 1958 and finally the Graduate School of Arts and Sciences in 1963. Ten departments now offer work at the graduate level.

The Master of Arts degree may be earned in economics, English, history, political science, psychology, sociology, and social anthropology. The Master of Science degree is available in biology, chemistry, clinical chemistry, mathematics, and physics. The Master of Science in Health Science and the Master of Public Administration degrees are also offered. In addition, there are programs leading to the Doctor of Philosophy degree in biology, chemistry, economics, mathematics, physics, psychology, and sociology.

GENERAL REGULATIONS

The general regulations of the graduate school that follow are minimal requirements shared by the several degree programs. The student is advised to consult the appropriate departmental section for a statement of specific requirements.

Application

All applicants should address inquiries to the Director of the Graduate School of Arts and Sciences. Initial correspondence directed elsewhere may result in valuable time lost in initiating the admissions procedure. Application forms and reference blanks will be mailed to the applicant. This material, together with complete official transcripts, the Graduate Record Examination scores when required, and the results of the Test of English as a Foreign Language, required of all applicants whose native language is not English, should be returned to the Director of the Graduate School of Arts and Sciences. Applications for those desiring assistantships should be submitted no later than March 15, however.

some departments have earlier deadlines. Applications received after this date may not be given equal consideration. All necessary supporting documents must be on file with the graduate school office at least four weeks before the date of registration for the quarter in which the student expects to begin his scholastic program. For more detailed information see departmental requirements for admission.

All applicants to the graduate school are strongly urged to take both the aptitude and advanced portions of the Graduate Record Examination. These tests are presently required in biology, economics, English, history, mathematics, political science, psychology, and sociology and anthropology. At least two letters of recommendation are required of all candidates. In biology, physics, psychology, and sociology and anthropology, three letters are necessary. Candidates for financial awards should so indicate to those supplying references.

Applications for the Graduate Record Examination can be obtained by writing to:

Educational Testing Service
Box 955
Princeton, New Jersey 08540

Applications for the Test of English as a Foreign Language can be obtained by writing to:

Educational Testing Service
Box 899
Princeton, New Jersey 08540

Admission

To be enrolled for graduate work, an applicant must submit a complete official transcript indicating the award of a bachelor's degree from a recognized institution and provide evidence that he is able to pursue creditably a program of graduate study in his chosen field. His scholastic record must therefore show distinction, and his undergraduate program show breadth as well as adequate preparation in the field in which the applicant expects to do advanced work. Admission to the graduate school is for a specific academic quarter. Students who fail to attend must reapply if they wish to do course work in a subsequent quarter. Acceptance to the school is granted upon recommendation of the departmental graduate committee after a review of the completed application. Foreign students who do not receive a graduate award or whose award is insufficient to cover all educational and living expenses must certify that they are able to meet all their expenses while at Northeastern. A visa may not be granted without such certification.

Student Classifications

Regular Student Those students admitted with a bachelor's degree showing a high quality of previous work.

Provisional Student Students whose records do not qualify them for enrollment as regular students. Provisional students must obtain a B average in the first 12 quarter hours of study for continuation in the degree program.

Special Student Students not matriculated in a degree program. Acceptance as a special student is in no way related to admission into a departmental degree program. However, those special students subsequently admitted into a degree program may apply the first twelve quarter hours of credit earned as a special student toward degree requirements. Special students are expected to maintain a B average in the first 12 quarter hours of study.

Doctoral Student Students admitted to a doctoral program.

Doctoral Degree Candidate Doctoral students who have completed 40 quarter hours of acceptable graduate work and have passed the qualifying examination.

Registration

Students must register within the dates and times listed on the school calendar. The place of registration will be announced prior to each period.

Residence

All work for advanced degrees must be registered for and completed at the University unless approval has been obtained from the director of the graduate school for work taken elsewhere.

Programs of Study

The study load for full-time students is usually four courses per quarter. Part-time students are limited to two courses per quarter unless permission to carry a heavier load is given by the departmental chairman or his designate. Courses in most fields are offered both in the afternoon and evening.

Grading System

The performance of students in graduate courses will be recorded by the instructor by use of the following grades:

A Excellent

This grade is given to those students whose performance in the course has been of very high graduate caliber.

B Satisfactory

This grade is given to those students whose performance in the course has been at a satisfactory level.

C Fair

This grade is given to those students whose performance in the course is not at the level expected in graduate work.

F Failure

This grade is given to those students whose performance in the course is unsatisfactory.

In addition, the following letter designations are used:

I Incomplete without quality designation.

This grade may be given to those students who fail to complete the work of the course.

L Audit without credit.

S Satisfactory without quality designation.

U Unsatisfactory without quality designation.

An S or U grade is used for the first quarter of a two-quarter sequence in which the grade for the second quarter applies to both the first and second quarters of the sequence.

The I grade will be changed to a letter grade when the deficiency which led to the I is made up to the satisfaction of and in the manner prescribed by the instructor in the course, or, in his absence, by the chairman of the department in which the grade is given. The period for clearing such a grade will be restricted to one calendar year from the date of its first being recorded on the student's permanent record.

Students must indicate their preference for auditing a course at registration. No credit will be given for the course. It will, however, appear on the student's transcript. Registration changes from an audit to a graded status, or vice versa, may only be made prior to the first day of classes.

Class Hours and Credits

All credits are entered as quarter hours. A quarter hour of credit is equivalent to three-fourths of a semester hour credit.

Continuity of Program

Students are expected to maintain continuous progress toward a degree. Any student who does not attend Northeastern for a period of one year must apply for readmission.

Withdrawals

In order to withdraw from a course, a student must fill out an official withdrawal form obtained at the Registrar's Office or at the Suburban Campus Office. Withdrawals may be made through the ninth week of the quarter. Students will be withdrawn as of the date on which they fill

out the form. Ceasing to attend a class or notifying the instructor does not constitute an official withdrawal.

Changes in Requirements

The continuing development of the graduate school forces frequent revision of curricula. In every new bulletin some improvements are indicated. When no hardship is imposed on the student because of changes, and when the facilities of the school permit, the student is expected to meet the requirements of the latest bulletin. If the student finds it impossible to meet these requirements, the bulletin for the year in which he entered becomes the binding one.

Application for the Diploma

If a commencement card is not filed with the Registrar's Office on or before the applicable date listed in the calendar, there is no assurance that the degree will be granted in that particular year even though all other requirements have been fulfilled.

THE MASTER'S DEGREE

Admission

Specific requirements for each degree program will be found in the appropriate paragraphs for each department.

Academic Requirements

A candidate for the master's degree must complete a minimum of 40 quarter hours of correlated work of graduate caliber and such other study as may be required by the department in which he is registered.

During the first half of the total number of hours of course work required for the degree, the candidate will be expected to maintain a minimum quality point average of 2.5. At the completion of three-fourths of the total number of hours of course work required for the degree, the candidate will be expected to have a quality point average of 2.8. To qualify for the degree, a final average of 3.0, equivalent to a grade of B, must be obtained. This average will be calculated quarterly by the graduate school on the basis of A = 4, B = 3, C = 2, and F = 0 and will exclude any transfer credits.

Not more than six quarter hours of repeated courses, additional courses, or permanent I's may be allowed in order to satisfy the requirements for the degree.

Within the above limitations, a required course for which a grade of F is received must be repeated with a grade of C or better, and may be repeated only once. If a grade of F is received in an elective course, that course may be repeated once to obtain a grade of C or better, or

another elective course may be substituted for it. If a grade of C is received in a required course, that course may be repeated once to obtain a grade of B or better.

Comprehensive Examination

A final written or oral comprehensive examination may be required. This examination will be given at least two weeks before the commencement at which the degree is expected.

Thesis

A thesis must show independent work based on original material, be approved by the departmental graduate committee, and must receive a grade of B or better to be accepted.

Language Requirement

An examination to show evidence of ability in one or more foreign languages is required in some graduate programs. This knowledge is established by an examination which will be administered by the graduate school at least twice yearly.

Transfer Credit

A maximum of 12 quarter hours of credit obtained at another institution may be accepted toward the master's degree provided that the credits transferred consist of A or B grades in graduate level courses, be in the candidate's field, have been earned at a recognized institution, and have not been used toward any other degree. Students should petition the director of the graduate school in writing for all transfer credit. Transfer credit grades may not be used for the purpose of obtaining the academic average necessary for the completion of the degree requirements.

Time Limitation

Course credits earned in the program of graduate study, or accepted by transfer, are valid for a maximum of seven years unless an extension is granted by the Committee of the Graduate School of Arts and Sciences.

THE DOCTOR OF PHILOSOPHY DEGREE

The Doctor of Philosophy degree is awarded to candidates who give evidence of high attainment and research ability in their major field. The degree requirements are administered by committees in charge of each degree program. These committees may be departmental graduate

committees or the committee of the graduate school depending upon the nature of the program. It is the responsibility of the chairman of the committee to certify to the Graduate School Office the completion of each requirement for each candidate.

Admission

Each degree program has an established admission procedure for students starting their doctoral work at Northeastern University.

Residence Requirement

Candidates for the Doctor of Philosophy degree must spend the equivalent of at least one academic year in residence at the University as a full-time graduate student. The committee of each degree program specifies the method by which the residence requirement is satisfied.

Qualifying Examination

Students must pass a qualifying examination within time limits set by the committee of each degree program.

Comprehensive Examination

Degree programs may require a comprehensive examination during the time in which a student is a degree candidate.

Course Requirements

The minimum course requirement of 40 quarter hours constitutes the work normally required for a master's degree. The course requirements beyond this in each doctoral program are specified by the committee in charge of the doctoral program.

Dissertation

Each doctoral student must complete a dissertation which embodies the results of extended research and makes an original contribution to the field. This work should give evidence of the candidate's ability to carry out independent investigation and interpret in a logical manner the results of the research. The method of approval of the dissertation is established by the committee in charge of the degree program.

Language Requirement

The foreign language requirement is established by the committee in charge of each degree program.

Final Oral Examination

The final oral examination will be on the subject matter of the doctoral dissertation and significant developments in the field of the

dissertation. Other fields may be included if recommended by the examining committee.

This examination will be taken after completion of all other requirements of the degree and must be held at least two weeks prior to the commencement at which the degree is to be awarded.

Transfer Credit

Approval for transfer credit may be given by the committee in charge of the degree program.

Time Limitation

After the establishment of degree candidacy, a maximum of five years will be allowed for the completion of the degree requirements.

Registration

All students must register for course work or dissertation as approved by their advisers or the departmental registration officer. After the first registration for doctoral work, registration must be continuous unless withdrawal is allowed by the committee in charge of the degree program. Students must be registered for dissertation during the quarter in which they take the final oral examination.

INTERDISCIPLINARY PROGRAMS

Some graduate students may wish to pursue doctoral programs which involve substantial work in two or more departments. To meet this need, an interdisciplinary program may be established which corresponds in scope and depth to doctoral standards, but does not agree exactly with the individual departmental regulations. For such possibilities, the following option is available:

Admission

Application for admission to interdisciplinary doctoral study consists of the submission of a carefully thought-out written proposal describing the areas of proposed study and research. The proposal may be a part of the initial application for admission to graduate study at Northeastern University, or it may be submitted by a student already enrolled. It may be directed to a doctoral degree-granting department or to the director of the graduate school who forwards it to the appropriate department. In either case, admission to interdisciplinary doctoral study requires favorable recommendation by the sponsoring doctoral degree-granting department and approval by authorized representatives of the graduate study committees of the departments appropriate to the disciplines covered by the applicant's proposal. The sponsoring department becomes the registration base of the student.

Formation of Interdisciplinary Committee

A student who has been accepted for interdisciplinary study must obtain the consent of an adviser who will direct his doctoral dissertation. This adviser, who may or may not be a member of the registration department, will be chairman of the interdisciplinary committee for this student. A second member will be appointed from the registration department by its chairman. These two members will obtain one or more additional members or request the director of the graduate school to do so. At least two departments must be represented on the committee and a majority of the committee must come from doctoral degree-granting departments. The chairman of the registration department will notify the director of the graduate school of the membership of the committee as soon as arrangements are complete.

Duties of Interdisciplinary Committee

A member of the interdisciplinary committee who is also a member of the registration department will serve as the registration officer to approve the course registration for the student. A copy of the approved course registration must also be filed with the other committee members and with the graduate study committee of the registration department.

The interdisciplinary committee will be responsible for the administration of the qualifying examination, language examination, approval of the dissertation, and comprehensive examination. This committee must also certify to the registration department the completion of the requirements for the award of the doctoral degree.

The interdisciplinary committee must assure that the program of the student represents standards comparable to those of the registration department and that the program is not so broad that it has inadequate depth in any area.

The program of the student may be reviewed at any time by the director of the graduate school to determine whether objectives of the program are being met.

Equal Opportunity Policy

Northeastern University is committed to a policy of providing equal opportunity for all. In all matters involving admission, registration, and all official relationships with students, including evaluation of academic performance, the University insists on a policy of nondiscrimination. Northeastern University is also an equal opportunity employer; it is institutional policy that there shall not be any discrimination against any employee or applicant for employment because of race, color, religion, sex, age or national origin. In addition, Northeastern takes affirmative action in the recruitment of students and employees.

financial information

FINANCIAL OBLIGATIONS

Tuition

Master's Degree Candidates

The tuition rate for 1974-1975 is \$57 per quarter hour of credit.

Doctoral Candidates

Tuition for full-time doctoral candidates in 1974-1975 is \$57 per quarter hour of credit. Doctoral candidates actively utilizing the resources of the university in their Ph.D. dissertation are charged an additional \$600 per quarter. Those doctoral candidates registered for dissertation work performed off campus are charged \$200 in addition to tuition charges each quarter, and those doctoral candidates who are no longer actively utilizing university resources are charged a continuation fee of \$50 per quarter.

Tuition statements are mailed to students by the Bursar's Office and are payable by check to Northeastern University.

Fees

An application fee of \$15 is charged all students when they apply for the first time in the graduate school at Northeastern.

Other fees include a charge of \$10 for late payment of tuition; a fee of \$25 for all degree candidates, payable before commencement by the applicable date listed on the academic calendar.

For full-time students there is a charge of \$12.50 per quarter for the services available in the Student Center. The fee for teaching assistants and research fellows is \$6.25 each quarter. All part-time students on the Huntington Avenue campus are charged \$.75 a quarter.

All full-time students will pay a nonrefundable University health services fee of \$90 each year. This fee will provide Blue Cross-Blue Shield coverage and entitle the student to the medical care furnished by the University Health Services. Tuition and fees are subject to change without notice.

All financial obligations to the University must be discharged by graduation.

Refunds

Tuition refunds will be granted only on the basis of the date appearing on the official withdrawal form filed by the student. Nonattendance does not constitute official withdrawal. Questions regarding refunds should be discussed with the Bursar's Office.

Refunds will be granted in accordance with the following schedule:

Amount of Refund	
Official Withdrawal Filed Within	Percentage of Tuition
First week of quarter	100
Second week of quarter	75
Third week of quarter	50
Fourth week of quarter	25

FINANCIAL AID

Northeastern University has available fellowships and assistantships for full-time students who are working toward the master's or doctor's degree. Candidacy for these awards may be established by completing the relevant section of the application for admission. Those students already enrolled should consult their departmental adviser.

Teaching Assistantships

Teaching assistantships allowing remission of tuition and a stipend are available in all departments. Holders of such awards devote half time to academic assistance directly related to the teaching function and the balance to course work.

Graduate Administrative Assistantships

Some University departments offer the graduate student an opportunity for remission of tuition and a stipend in return for half time spent in assisting with nonteaching, administrative duties.

Tuition Assistantships

Many departments provide remission of tuition to full-time students assisting eight hours a week in the administrative work of the department. These awards are normally given to students in the first year of graduate work.

Research Fellowships

A number of departments offer research fellowships including N.I.H., N.S.F., and N.D.E.A. carrying a stipend and remitting tuition. Certain of these grants require half-time work on research in the department,

with the remaining time devoted to course work. Others provide for full-time work on research used for a thesis or dissertation.

Martin Luther King, Jr., Scholarships

A limited number of full- and part-time Martin Luther King, Jr., Fellowships are available. These scholarships provide for remission of tuition and all fees, and are awarded to qualified black students on the basis of financial need. Additional information and application forms are available from the Office of Financial Aid.

Robert A. Feer Scholarship

This scholarship is awarded yearly to the outstanding candidate for the Master of Arts degree in History. The scholarship was established in memory of Professor Robert A. Feer who was a member of the Department of History from 1963 to 1970.

Appointments

Appointments to fellowships and assistantships are ordinarily announced no later than April 15 for the following academic year or summer. Appointments are for a maximum of three quarters and are not automatically renewed. Students who hold assistantships and research fellowships are expected to devote full time to their studies and the duties of the award. They may not accept outside employment without the consent of their faculty adviser and the director of the graduate school.

Dormitory Proctorships

A number of proctorships for men in dormitories on or near the Huntington Avenue campus are available each year. Appointments carry a minimum compensation of room and board. Further information and application forms may be obtained from the Office of University Housing.

National Direct Student Loan

This program is available to students who are carrying at least one-half the normal academic work load, are accepted as degree candidates, and who show evidence of financial need.

The Federal maximum which a graduate student may borrow while pursuing a post-baccalaureate degree is \$5,000.

Repayment and interest on these loans do not begin until nine months after the student ceases to carry at least a half-time academic load at an institution of higher education. The repayment of principal may be extended over a 10-year period with the interest at the rate of three percent per annum. Repayment may be deferred up to a total of three years while a borrower is serving as a Peace Corps or VISTA volunteer.

Guaranteed Student Loan Program

Under this program, students who are matriculated degree candidates, enrolled for at least one-half the normal academic work load, may borrow from a participating bank or other financial institution. Terms and conditions vary from state to state, but a student generally may borrow up to \$1,500 a year (the law allows a maximum of \$2,500 per year) depending on financial need. The Federal government pays the interest while the student is in school if the student is eligible for interest subsidy.

The student must have submitted, through the College Scholarship Service, a Parents' Confidential Statement; or if he has been declared financially independent by the Financial Aid Office, a Students' Confidential Statement. These forms are available in the Financial Aid Office.

Applications for the loan itself are available from local banks or the Education Office of your state government. Additional information and necessary application forms for Massachusetts residents are available from the Financial Aid Office.

The federal aid programs listed above are available to citizens and permanent residents of the United States.

fields of study

The departmental sections that follow list courses available to a student during the typical period of attendance required to obtain a degree. The quarter in which a specific course will be offered will be found in the course announcement made available in May for the summer quarter and in June for the following academic year.

biology

Professors

Francis D. Crisley, Ph.D.,
Chairman
Charles Gainor, Ph.D.
Abdul-Karim Khudairi, Ph.D.
John F. Reinhard, Ph.D.
Nathan W. Riser, Ph.D., Director,
Marine Science Institute

Associate Professors

Charles H. Ellis, Jr., Ph.D.
Janis Z. Gabliks, D.D.S., Ph.D.
Charles A. Meszoely, Ph.D.
M. Patricia Morse, Ph.D.
Joseph V. Pearincott, Ph.D.
Fred A. Rosenberg, Ph.D.
Ernest Ruber, Ph.D.
Brunhild I. E. Stuerckow, Dr.
rer. nat.

Henry O. Wernitz, Ph.D.

Assistant Professors

Troy L. Best, Ph.D.
Harvey S. Bialy, Ph.D.
Helen Lambert, Ph.D.
Dale F. Levering, Jr., Ph.D.
Daniel Scheirgr, Ph.D.
Phyllis R. Strauss, Ph.D.

THE MASTER OF SCIENCE DEGREE Full-Time Program

THE MASTER OF SCIENCE IN HEALTH SCIENCE DEGREE Part-Time Program

Admission

In addition to the requirements listed on page 20 applicants should have a background which includes one year of organic chemistry, physics, and mathematics and six quarter courses of the biology undergraduate core curriculum or its equivalent. Students admitted with deficiencies should remove them during the first 20 quarter hours of graduate work.

Program

Forty-six quarter hours of academic work are required. A candidate for either degree is expected to take forty hours of course work including four hours of seminar, and one laboratory course in microbiology, unless previously taken elsewhere. Transfer credits will be accepted only from those schools offering graduate programs in biology. Application for such credit should be made in writing to the director of the graduate school during the first quarter following the student's assignment to an academic adviser. Other limitations on transfer credit are

listed on page 26 Graduate courses in departments other than Biology will be accepted for credit up to a limit of 12 quarter hours, including those credits previously accepted as transfer credits, upon written recommendation from the student's adviser to the graduate director for final approval.

During his tenure, in addition to the above course requirements, each student pursuing work toward the master of science degree in the full-time program must enroll for a minimum of six credits of work in 18.990, Special Topics in Biology, or 18.991, Research for the Master of Science degree. After initial election of either 18.990 or 18.991 the student must register for either of these courses for each quarter until the work is completed. Work in 18.990, Special Topics in Biology, is pursued under the supervision of an individual faculty member, by mutual agreement. It may take the form of a comprehensive, critical review of the literature in a specialized area and/or a specific program of experimental work on a single topic. If experimental work has been elected under 18.990 it may later be expanded, with permission of the departmental graduate committee, into a master's thesis with a topic and adviser and a committee of three members approved by the departmental graduate committee. Grades in 18.990 or 18.991 are recorded as "Satisfactory" until all work is completed, culminating in either a comprehensive, well-written report — which must be reviewed by the department graduate committee — or a thesis. A comprehensive examination in the last six months of the master's program is required of all students, except those presenting a thesis. For the latter a final oral examination on the thesis is required. The department encourages the pursuit of a thesis wherever feasible.

The program leading to the Master of Science in Health Science degree is designed for part-time students who may progress according to their abilities, the time available, and the need or desire to extend their education into interdisciplinary work involving biology or allied areas such as the health sciences. Students may elect to substitute six quarter hours of course work credit for the required 18.990, Special Topics in Biology or 18.991, M.S. Thesis. Those students electing the course option must take a comprehensive examination in the last six-month period of their program, similar to the examination required of students pursuing Special Topics work. With the permission of the departmental graduate committee the two master's degree programs are interchangeable. If their schedules permit, students in the M.S. in Health Science program may carry out their work on a full-time basis.

THE DOCTOR OF PHILOSOPHY PROGRAM

Admission

Applicants who will have a master's degree or its equivalent at entry may be considered for direct admission to the doctoral program. Those

who will not may be considered only for admission to the master's program, and, after satisfactory completion of 30 quarter hours of graduate study, may then be considered for admission to the doctoral program.

Residence Requirement

After he has been admitted to the doctoral program, the student may satisfy the residence requirement by one year of full-time graduate work or by two years of half-time graduate work. However, a student should expect to spend at least two years or the equivalent in full-time study.

Degree Candidacy

Degree candidacy is established in accordance with the general graduate school regulations.

Qualifying Examination

Students entering the doctoral program will be expected to have had the equivalent of an M.S. degree at Northeastern before taking their qualifying examination. Students who have been accepted into the doctoral program will normally be expected to complete the qualifying examination by the end of three quarters at Northeastern University at a time specified by the departmental graduate committee. The candidate will be expected to demonstrate an advanced knowledge of biological concepts. The examination will be oral and approximately two hours in duration. Eligibility to continue in the program toward the Doctor of Philosophy degree is contingent upon satisfactory performance on the qualifying examination.

Comprehensive Examination

The comprehensive examination requirement will be fulfilled by two written examinations, one in the major area of specialization and the other in closely related areas. The candidate may apply through his adviser after completing the foreign language requirement and at least one quarter prior to the oral examination.

Course Requirements

After the establishment of candidacy, any further course requirements will be established by the dissertation adviser and approved by the departmental graduate committee.

Dissertation

In most cases, arrangements for the dissertation director will have been made before the completion of the qualifying examination. If not, such arrangements must be made as soon as possible after degree

candidacy has been established. The dissertation director advises the candidate on the research for the dissertation, which is to be performed in accordance with general graduate school regulations. He serves as chairman of the dissertation committee, which must approve the dissertation before the degree may be conferred. The doctoral committee shall consist of at least five members.

Language Requirement

Ability to read and translate biological literature in one foreign language must be established by the candidate. In order to maximize the usefulness of this language as a tool of research, the student should take the language examination as early as possible. The examination will be administered by the Department of Biology, or in certain cases, by the Modern Language Department. French, German, and Russian are the three most important foreign languages for the biologist. Students will be expected to choose one of these languages for their examination, but another language may be substituted where there is significant literature in the area of interest.

Tool of Research

A tool of research is required in addition to the above language. This requirement may be fulfilled through either passing a second foreign language examination in a language in which there is significant literature, or completion of a program in the general principles of statistics, biometry, and/or computer programming.

Final Oral Examination

This examination will be held in accordance with the general regulations of the graduate school.

INTERDISCIPLINARY PROGRAMS

Admission

Application and credentials for admission to interdisciplinary programs involving the Biology Department, where this department is clearly the department of registry, as described under "General Regulations," should be submitted as described under the heading of "Admission" in the section "The Doctor of Philosophy Program" for biology. The interdisciplinary committee will consist of at least five members. The composition of this committee will be determined by mutual consent between the departments involved, but will have at least three members from the Biology Department if the dissertation adviser is from this department. Upon admission, suitable interdisciplinary course requirements will be determined by the interdisciplinary committee.

Qualifying Examination

Students accepted into the program will normally be expected to complete the qualifying examination by the end of three quarters at Northeastern University. At least five areas of study will be covered by the qualifying examination, at least three of which will be oral examinations chosen by the candidate from the following areas: biochemistry, botany, ecology, genetics, microbiology, physiology, and zoology. The remaining components of the examination will be specified and evaluated by the other participating department. With the exceptions of the procedures for admission and examinations for qualification, the remaining requirements and procedures are as specified under "The Doctor of Philosophy Program" for biology.

DESCRIPTION OF COURSES

All courses carry four quarter hours of credit unless otherwise specified.

18.803 Biometrics

Statistical methods applied to biological samples and analysis of biological research data. *Prep. Algebra*

18.804 Lower Invertebrates

Taxonomy, morphology, embryology, and life histories of acoelomate phyla (Marine Science Institute).

18.805 Coelomate Invertebrates

Biology of annelida, arthropoda, mollusca, and echinodermata (Marine Science Institute).

18.806 Malacology

Functional morphology, embryology, systematics, and ecology of the major groups of mollusks. *Prep. Invertebrate Zoology.*

18.808 Vertebrate Zoology (5 q.h.)

Evolution, phylogeny, anatomy, physiology, behavior, population dynamics, reproduction, etc., of the vertebrates. Field collection, preparation, and study of local vertebrates will be carried out in the laboratory. *Prep. Comparative Anatomy or Embryology.*

18.809 Mammalogy (5 q.h.)

Phylogeny, anatomy, physiology, behavior, reproduction, population dynamics, and natural history of the mammals. The course will include student presentation of the recent advances in mammalogy. Field collection and laboratory preparation and study of specimens will be included. *Prep. Comparative Anatomy or Embryology.*

18.810 Ichthyology

Natural history and systematics of fishes, with emphasis on marine species (Marine Science Institute).

18.813 Dynamics of Aquatic Ecology I (3 q.h.)

Chemical, physical and biotic factors influencing coastal and lake communities. Lectures. *Prep. 18.134 or 18.834 or equivalent.*

18.814 Dynamics of Aquatic Ecology II (3 q.h.)

One hour of lecture and one full day (7 hours) of laboratory-field work. *Prep. 18.813.*

18.815 Biological Factors in Ocean Engineering (2 q.h.)

Natural biological phenomena and their relationship with man-made alterations of the sea. *Prep. Registration in a graduate engineering program.*

18.818 Ecology of Salt Marshes (3 q.h.)

Survey of fauna and flora, environmental factors affecting them and current biological and social problems associated with this habitat. This course will meet for 2 lectures of 1½ hours each and 1 full day of laboratory for 6 weeks during the summer quarter. *Prep. A basic ecology course or consent of the instructor.*

18.819 Principles of Systematics (3 q.h.)

Codes of nomenclature. Biological principles basic to methodology of the preparation of monographs and of faunas and floras.

18.823 Human Ecology

Parameters of the human ecological niche, man's effect on them, and their consequences for him. *Prep. Basic Ecology or consent of instructor.*

18.825 Plant Nutrition and Metabolism

Mineral nutrition, photosynthesis, metabolic pathways, and translocation in higher plants.

18.826 Plant Growth and Reproduction

Plant hormones, growth, development, and physiology of reproduction. *Prep. 18.825.*

18.827 Physiology of Plant Growth and Development (2 q.h.)

A general coverage of the internal and environmental factors that influence the physiology of plant growth and development. The mechanisms by which plant growth hormones regulate the physiology of plants will be discussed with particular emphasis on the roles of auxins, gibberellins, cytokinins, and phytochrome. *Alternates yearly with 18.833.*

18.829 Fossil Plants (3 q.h.)

Plant forms from past times.

18.830 Marine Algae

Systematics, life histories, and ecology of marine algae, with emphasis on the flora of the Gulf of Maine (Marine Science Institute).

18.831 Plant Morphogenesis I

A study of the continually unfolding series of changes in the life of the plant. The origin of form, experimentally controlled development, and external and internal factors that govern development of form. *Prep. 18.137, 18.234.*

18.832 Plant Morphogenesis II

Plant tissue, organ, and cell culture techniques employed in the study of morphogenetic processes. *Prep. 18.831.*

18.833 Photosynthesis (2 q.h.)

A general discussion of the biochemistry and physiology of photosynthesis with particular emphasis on recent discoveries in electron transport, chloroplast structure, and CO₂ assimilation. The evolution and requirements of photosynthesis will also be discussed. *Prep. 18.827. Alternates yearly with 18.827.*

18.834 Environmental and Population Biology (2 q.h.)

Physico-chemical factors influencing and influenced by organisms. Interactions among individual organisms and among species. Students will participate in lectures and laboratories given for 18.134. Individual work on specialized aspects of ecology will be assigned. *Prep. One year of General Biology, including plant and animal biology.*

18.836 Cardiovascular Physiology (3 q.h.)

Physiology of blood cells, anemia, polycythemia immunity and allergy. Electrophysiology of the heart, cardiac cycle, EKG, hemodynamics, capillary dynamics, pulmonary circulation, cardiovascular reflexes, cardiac output and venous return. Cardiac failure, coronary circulation, atherosclerosis, hypertension, cerebral circulation, circulatory shock.

18.837 Cardiovascular Physiology Laboratory (1 q.h.)

Three hours of laboratory study per week. *Prep. 18.836.*

18.838 Animal Nutrition (2 q.h.)

Detailed consideration of organic and inorganic nutritional requirements of man and selected animals. Digestion, absorption, and metabolism of nutrient materials. Role of vitamins, minerals, and trace elements in metabolism. Variation in nutritional needs among normal individuals and in various physiologic and genetic pathologies. Evaluation of food additives and of permissible levels of toxic materials in food.

18.840 Comparative Physiology of Regulatory Mechanisms (2 q.h.)

Principles and selected examples of physiological response to environmental variation. *Prep. Basic Physiology.*

18.842 Vertebrate Endocrinology (2 q.h.)

Principles of hormonal regulation of physiological processes in vertebrates, mechanisms of hormone action, neuro-endocrine relationships. *Prep. Physiology.*

18.843 Procedures in Endocrinology (3 q.h.)

Laboratory techniques used in the study of endocrine activity in vertebrates. *Prep. 18.842.*

18.845 Physiological Ecology (2 q.h.)

Study of biological and chemical mechanisms involved in adaptation; homeostasis and its regulation, salt and water metabolism; respiratory and circulatory control systems; adaptation versus acclimation. Control systems within the body versus set points. *Prep. College Biology, Organic Chemistry.*

18.846 Nuclear and Radiobiology (2 q.h.)

Interaction of radiation and biological matter; isotopic tracer techniques; isotopes and biochemical reactions, radiation ecology, activation analysis and its application in biological and forensic sciences. *Prep. College Biology, Organic Chemistry.*

18.847 Scientific and Legal Interactions of Environmental Management (2 q.h.)

The kinds of scientific information required for implementation of the legal and political aspects of environmental management. The role of the scientist as an expert witness. Scientific and legal predictability. Analyses of suitable dynamic models and case law with the goal of improving the results of legal, political, and scientific decisions bearing upon remedial environmental management. *Prep. Biology core and first course in physiology, e.g., 18.158 and 18.159.*

18.852 Advanced Developmental Biology (3 q.h.)

Analysis of development at the biochemical and cellular levels. Nucleic acid and protein synthesis, gene action and differentiation, cell-cell interactions, mechanisms of animal morphogenesis. 3 hrs. of lecture. *Prep. 18.135, 18.136 or consent of the instructor.*

18.853 Advanced Developmental Biology Laboratory (2 q.h.)

Analysis of the fundamental problems of development through experimental techniques. Culture of vertebrate and invertebrate embryos; microsurgical analysis of morphogenesis; biochemistry of development, cell-cell interactions; organ and tissue culture will be studied. 5 hours of laboratory per week. *Prep. 18.852 or consent of the instructor.*

18.857 Advanced Mammalian Physiology (4 q.h.)

Intensive study of the physiological systems of mammals. For students with previous background in physiology. *Prep. Consent of the instructor.*

18.858 Advanced Mammalian Physiology Lab (3 q.h.)

Experimental study of the circulatory, digestive, excretory, reproductive, nervous, and endocrine systems in mammals, with emphasis on laboratory procedures and surgical techniques used with living animals — chiefly, the rat. *Prep. 18.857 or consent of the instructor.*

18.860, 18.861 Cell Biophysics and Biochemistry I, II (5 q.h.)

Biogenesis and ultrastructure of the cell considered together with the biophysical procedures and biochemical patterns used in the study of cellular and tissue components. *Prep. Organic Chemistry and General Biology.*

18.863 Neurophysiology (2 q.h.)

The biophysical function of nerve cells including the resting potential energy, the reception and transmission of stimuli, and the coding of neuronal signals.

18.864 Neurophysiology Laboratory (2 q.h.)

Introduction into neurophysiological methods. *Prep. 18.863 (may be taken concurrently).*

18.870 Tropical Field Studies (1 q.h. per week)

Field work under direct supervision of faculty.

18.871 Evolution (3 q.h.)

Current concepts and selected examples of the process and results of evolution. The modern synthesis draws upon biochemical, physiological and genetic evidence as well as classic morphological and biogeographical evidence. Discussion led by students and faculty. *Prep. 18.131-18.136, or equivalent.*

18.880 Computers in Biology

Programming and use of computers as a tool to solve research problems. Special emphasis will be placed on problems arising in biological research and related fields. Students will solve a spectrum of problems on the University computer.

18.903 Environmental Microbiology

The microbial environment and ecology of the cell. Interactions between microbial populations, stressing soil and fresh-water associations. *Prep. 18.220 or equivalent.*

18.905 Marine Microbiology

Morphological, physiological, and ecological factors concerning marine microorganisms. Taxonomic problems, microbial association, and general methodological approaches to the study of marine microorganisms. *Prep. 18.220 or equivalent.*

18.907 Food Microbiology (2 q.h.)

Microbiology of food with emphasis on the pathogenic types and their interactions with other groups indigenous to food. *Prep. 18.220 or equivalent.*

18.908 Food Microbiology Laboratory (2 q.h.)

Detection, quantification, and isolation of microorganisms and their products of significance in food with emphasis on the pathogenic types. *Prep. 18.907 (may be taken concurrently).*

18.909 Animal Virology

Physical and chemical properties of viruses. Viruses as intracellular parasites. Viral replication and genetics, host-virus interaction, pathogenesis, diseases, tumor viruses, and serological reactions. Laboratory sessions will consist of demonstrations emphasizing use of animals, eggs and animal cell cultures for cultivation, isolation, and identification of viruses. *Prep. 18.220 and 18.242 or their equivalent and Biochemistry.*

18.910 Microbial Genetics (3 q.h.)

Principles of bacterial and bacteriophage genetics. Nature of variation and inheritance and the mechanisms of exchange of genetic material. *Prep. 18.220 or equivalent.*

18.911 Microbial Genetics Laboratory (2 q.h.)

Origin, isolation, and characterization of mutants. Mechanisms of genetic exchange in bacteria and bacteriophage. *Prep. 18.910 (may be taken concurrently).*

18.914 Medical Mycology (2 q.h.)

Morphological, pathological, and epidemiological factors of pathogenic opportunistic and common fungal contaminants from human sources. *Prep. 18.220 and 18.224 or equivalents.*

18.915 Medical Mycology Laboratory (2 q.h.)

Basic methodology for demonstration and isolation of fungi in clinical specimens. Identification on morphologic and biochemical basis. *Prep. or co-requisite 18.914.*

18.920 Industrial Microbiology (3 q.h.)

Microorganisms and methods employed in production of products of economic and medical importance, decomposition of wastes, and control of desirable and unwanted processes and biodeterioration. Fermentation processes emphasized. *Prep. 18.240 or equivalent or consent of instructor.*

18.921 Industrial Microbiology Laboratory (2 q.h.)

Laboratory and discussion seminar sessions devoted to the study of selected commercial processes.

18.940 Microbial Biochemistry

Study of the enzymatic reactions, intermediate products, and metabolic pathways involved in carbohydrate, protein, and nucleic acid metabolism by microorganisms. *Prep. 18.220 and 18.240 or equivalents, and Biochemistry.*

18.980 Seminar (1 q.h.)

Various topics and newer developments in botany, microbiology, physiology, and zoology covered in depth. Student presentations are emphasized.

18.990 Special Topics in Biology (credit variable)

Special study of a selected topic under direction of a faculty member. Topic and direction of study to be arranged with the faculty member supervising the study.

18.991 M.S. Thesis

Research methods of some special field and their application to a specific problem, under direction of a faculty member.

18.992 Special Investigations in Biology (credit variable)

Laboratory studies on a topic not directly related to research being pursued for a thesis or dissertation.

18.993 Biological Electron Microscopy

Electron Microscopy as a tool in research with emphasis on specimen preparation, particularly ultra-thin sectioning. Lectures and student seminars will cover theory, laboratory procedures, and discussion of methods not used in the laboratory. Classes will meet at Henderson House, Weston, one day per week (3 hours of lecture, 4 hours of laboratory) on a day selected by mutual agreement between the class and the instructor. Given in cooperation with the Center for Continuing Education. Limited to 8 students upon certification in writing by their thesis advisers to the department chairman that the course is to be significantly applied in thesis research. Students are accepted subject to approval by the instructor.

18.995 Ph.D. Dissertation

Original research in depth, representing a significant contribution of new biological knowledge, and a written dissertation thereon, under the supervision of a faculty member.

73.814 Concepts in Pharmacology I (2 q.h.)

Selected areas of pharmacology are examined in depth with special reference to interactions of drugs and other chemical agents with biological systems. Emphasis is placed on biochemical mechanisms, experimental design, evaluation of data utilizing conventional statistical procedures, and techniques employed in pharmacological evaluations. Alternates yearly with 73.816.

73.815 Concepts in Pharmacology II (2 q.h.)

Continuation of 73.814.

73.816 Concepts in Toxicology I (2 q.h.)

Concepts of modern toxicology in which emphasis is placed on biochemical mechanisms underlying the toxicological action of drugs and other chemical substances upon biological systems. Selected topics in toxicology, including acute, subacute, and chronic effects of drugs in the experimental animal. Consideration of the predictive value of animal studies for drug effects in man. Alternates yearly with 73.814.

73.817 Concepts in Toxicology II (2 q.h.)

Continuation of 73.816.

01.952 Industrial Hygiene (2 q.h.)

Factors in the industrial environment that adversely affect the health, comfort, and efficiency of the worker. Industrial surveys, and application of engineering principles to control of dust, toxic metals, gases and vapors, organic compounds, radiation, pressure, temperature, and humidity.

01.957 Air Pollution Science (2 q.h.)

Theory and practice related to engineering management of air resources, control of gaseous emission, investigation and study of air pollution, sampling and analysis methods.

90.821 Biochemistry I (2 q.h.)

Discussion of the structures and chemistries of carbohydrates, proteins, lipids, nucleic acids, and selected cofactors. *Prep. One year Organic Chemistry.*

90.822 Biochemistry II (2 q.h.)

Bioenergetics, enzymes and enzyme kinetics, intermediary metabolism, including carbohydrate catabolism, tricarboxylic acid cycle, electron transport, and oxidative phosphorylation. *Prep. Biochemistry I (90.821).*

90.823 Biochemistry III (2 q.h.)

Continuation of intermediary metabolism from Biochemistry II, or 73.842, including lipid, protein, and nucleic acid metabolism, photosynthesis, and cell regulation. *Prep. Biochemistry II (90.822).*

All undergraduate biology courses in the series designated 18.200-18.300, and selected other courses as indicated below, are available for graduate credit. Please consult the undergraduate or other appropriate bulletin for course details.

18.208 Comparative Vertebrate Anatomy	3 cl. 6 lab. 5 q.h.
18.209 Developmental Anatomy	3 cl. 6 lab. 5 q.h.
18.210 Invertebrate Zoology	3 cl. 6 lab. 5 q.h.
18.211 Parasitology	3 cl. 3 lab. 4 q.h.

18.212	Vertebrate Paleontology	3 cl. 3 lab. 4 q.h.
18.214	Current Topics in Parasitology	3 cl. 3 q.h.
18.215	Advanced Parasitology Lab	4 lab. 1 q.h.
18.220	General Microbiology	3 cl. 6 lab. 5 q.h.
18.227	Animal Histology	3 cl. 3 lab. 4 q.h.
18.228	Histological Technique	1 cl. 6 lab. 3 q.h.
18.231	Lower Plants	3 cl. 3 lab. 4 q.h.
18.232	Higher Plants	3 cl. 3 lab. 4 q.h.
18.233	Systematic Botany	2 cl. 6 lab. 4 q.h.
18.234	Plant Anatomy	2 cl. 6 lab. 4 q.h.
18.235	Economic Botany	3 cl. 3 lab. 4 q.h.
18.236	Horticulture	3 cl. 3 lab. 4 q.h.
18.237	Introduction to Plant Physiology	3 cl. 6 lab. 5 q.h.
18.238	Local Flora	3 cl. 4 lab. 4 q.h.
18.239	Terrestrial Ecosystems of North America	3 cl. 4 lab. 4 q.h.
18.240	Microbial Physiology	3 cl. 4 lab. 4 q.h.
18.242	Medical Microbiology	3 cl. 4 lab. 4 q.h.
18.245	Serology-Immunology	3 cl. 3 q.h.
18.246	Serology-Immunology Laboratory	6 lab. 2 q.h.
18.251	Comparative Animal Physiology	3 cl. 3 lab. 4 q.h.
18.252	Mammalian Physiology I	2 cl. 3 lab. 3 q.h.
Structural and biochemical aspects of mammalian cells. Bioelectric phenomena; muscle and nerve function; renal physiology. <i>Prep. Course in Vertebrate Anatomy or consent of the instructor.</i>		
18.253	Mammalian Physiology II	2 cl. 3 lab. 3 q.h.
Physiology of cardiovascular, respiratory and digestive systems. Reproductive and endocrine physiology. <i>Prep. 18.252.</i>		

chemistry

Professors

Karl Weiss, Ph.D.
Chairman
Bill C. Giessen, Dr. Sc. Nat.
Barry L. Karger, Ph.D.
Albert H. Soloway, Ph.D.
Alfred Viola, Ph.D.

Associate Professors

William E. Cass, Ph.D.
David M. Howell, Ph.D.
Conrad M. Jankowski, Ph.D.
Elmer E. Jones, Ph.D.
Philip W. LeQuesne, Ph.D.
John L. Roebber, Ph.D.
Robert N. Wiener, Ph.D.

Assistant Professors

Thomas F. Brennan, Ph.D.
Thomas R. Copeland, Ph.D.
Geoffrey Davies, Ph.D.
Arthur M. Halpern, Ph.D.
Henry E. Keller III, Ph.D.
James E. Quick, Ph.D.
William M. Reiff, Ph.D.

Admission

In addition to the admission requirements listed on page 20 an applicant must have completed not less than four full-year chemistry courses of the level required of an undergraduate major in chemistry. These must include organic, physical, and analytical chemistry. Admission policy favors those who have taken more chemistry than these minima. In addition, one year each of college physics and calculus are required, and further work in these subjects is desirable.

For the full-time program, these admission requirements may be modified to accommodate applicants who have taken fewer courses than indicated above, but who have outstanding records and a strong interest in chemical or interdisciplinary research. See also the description of interdisciplinary programs.

THE MASTER'S DEGREE

Full-Time Program

The normal full-time program consists of a total of 40 quarter hours of courses, seminars, research, and a thesis based on this research. Each student is required to take at least 24 quarter hours of credit in courses. A minimum of 6 hours, but no more than 14 quarter hours of credit may be assigned to 12.991, Research and Thesis for the Master of Science degree. Each student is required to attend 12.990, Seminar, in each term. One credit is assigned to a student for each term in which he conducts a seminar, up to the maximum of two credits.

Part-Time Program

The admission requirements for this program are the same as for the full-time program, but course requirements differ, and students may progress according to their abilities and the time available.

Thirty-two credits must be taken in graduate offerings of the Department of Chemistry. Eight additional credits may be taken in any graduate courses for which the student has the necessary prerequisites. The student's program shall include:

- (a) Four credits of organic chemistry. These will normally be 12.861 and 12.862.
- (b) Four credits of inorganic chemistry. These will normally be 12.841 and 12.842.
- (c) Four credits of analytical chemistry. These may be chosen from 12.821, 12.822, and 12.823.
- (d) Four credits of physical chemistry. These may be chosen from 12.881, 12.882, 12.885, 12.886, and 12.893.

In cases of unusual preparation, more advanced courses may be substituted within the given subdiscipline.

THE DOCTOR OF PHILOSOPHY DEGREE

The doctoral program in chemistry may be pursued only in residence. The additional requirements beyond those of the master's degree are designed to demonstrate superior proficiency in original research, including technical reading ability in a foreign language and familiarity with current advances in one of the main divisions of chemistry.

Residence Requirement

The residence requirement is satisfied after one year of full-time graduate work or two years of half-time work. If a student holds a teaching assistantship which occupies one half of his time, his residence requirement is being discharged at half rate. Other arrangements require faculty approval. If a candidate has a research fellowship which supports his research for the doctoral dissertation, his residence requirement is discharged at full rate. Normally, the equivalent of two years of work after establishment of doctoral candidacy is necessary to complete research.

Degree Candidacy

Degree candidacy is established in accordance with the general graduate school regulations.

Qualifying Examination

Qualifying examinations are offered in the fields of analytical, inorganic, organic, and physical chemistry. There are eight examinations offered each year in each field. A student must pass four of these.

A student is eligible to take the qualifying examination if:

- (a) he has entered with a bachelor's degree and has achieved a 3.0 average in eight courses taken in the first year of residence;
- (b) he has been admitted to the doctoral program with an awarded master's degree;
- (c) he is a part-time student who has petitioned the department after having completed at least sixteen credits of graduate courses which include fulfillment of three of the four distributional requirements listed for the part-time program. A 3.0 average is required for all courses taken.

Students in category "a" must pass the qualifying examinations by July 1 of their second year of residence. Students in category "b" must pass the qualifying examinations by July 1 of their first year of residence. Students in category "c" will have the conditions set at the time their petition is approved.

Course Requirements

A candidate is normally required by his faculty adviser to do some course work beyond the 40 quarter hour minimum. The number and nature of these courses are individually determined for each candidate.

Dissertation

In most cases, arrangements for a dissertation adviser will have been made before the completion of the qualifying examination. If not, such arrangements must be made as soon as possible after degree candidacy has been established. The dissertation adviser directs the research for the dissertation and serves as chairman of the dissertation committee, which must approve the dissertation before the degree may be conferred.

Language Requirements

Proficiency must be demonstrated in a foreign language as specified by the departmental graduate committee in accordance with the general graduate school regulations. French, German, and Russian are the acceptable foreign languages. Normally, proficiency is demonstrated by taking examinations administered by the Chemistry Department.

Final Oral Examination

This examination will be held in accordance with the graduate school regulations.

DESCRIPTION OF COURSES

All courses carry two quarter hours of credit except seminar and research.

12.806 Chemical Aspects of the Environment

Consideration of problems related to air, water, food, drugs, energy, and materials. The lectures are given by experts in various fields, and are followed by discussions. *The course is open to all students with a bachelor's degree in science or engineering. It may not be used by full-time students to establish doctoral student status.*

12.821 Analytical Separations

Theory and practice of analytical separation techniques. Emphasis will be on fundamentals as they relate to practice. Topics will be based mainly on chromatographic processes including gas and high speed liquid chromatography. Other topics will include zone refining, liquid-liquid extraction, and electrophoresis.

12.822 Electroanalytical Chemistry

The principles and practice of electroanalytical chemistry will be discussed. Topics will include potentiometry and ion-selective electrodes, normal and thin-layer coulometry, polarography, and electrochemical relaxation methods. Application of these techniques to titration endpoint detection will also be discussed.

12.823 Optical Methods of Analysis

The theory and practice of absorption and emission spectroscopy. Instruments, methods, and applications will be considered.

12.824, 12.825, 12.826 Special Topics in Analytical Chemistry I, II, III

Selected topics of current importance in analytical chemistry.

12.827 Computers in Chemistry

A laboratory-lecture course illustrating the use of small digital computers for real-time control of chemical instruments. Topics will include digital logic, real-time data structures, A/D and D/A conversion, noise, and other aspects of real-time computer interfacing. Programming will be done on a PDP-11 computer in MIRACL, a language designed for real-time processing. *Prep. Consent of instructor.*

12.828 Chemical Instrumentation

Principles of instrument design will be considered with emphasis on practical aspects. Instrument limitations and sources of error will be considered along with modular instruments and interfacing. *Prep. Consent of instructor.*

12.841 Advanced Inorganic Chemistry I

Application of basic quantum chemistry to inorganic systems. Russell-Saunders and j-j coupling. Stereo chemistry of non-transition-metal compounds; bonding and structure of electron deficient systems.

12.842 Advanced Inorganic Chemistry II

Magnetic properties; electronic spectra and selection rules. Thermodynamic stability of coordination compounds. Experimental techniques of inorganic chemistry. *Prep. 12.841.*

12.843 Advanced Inorganic Chemistry III

Crystal symmetry. Introduction to theory of solids; semi-conductors and metals; non-stoichiometric compounds; solid state reactions. Application of molecular orbital theory. Determination of electron distribution in transition metal compounds. Moessbauer spectroscopy and advanced magneto-chemistry. *Prep. 12.842 and 12.885.*

12.846 Coordination Chemistry

Coordination compounds: their experimental detection, calculation of stability constants, factors affecting solubility and stability constants. Ligand field theory. Acidity, color, and lability of complexes. Kinetic and stereochemical studies of inorganic reaction mechanisms. *Prep. 12.843.*

12.847, 12.848, 12.849, 12.850 Special Topics in Inorganic Chemistry I, II, III, IV
Selected topics of current importance in inorganic chemistry. *Prep. 12.842 and consent of instructor.*

12.851 Structure Determination in Solids

X-ray, electron, and neutron diffraction; elements of crystallography; computer-aided calculations. Analytical techniques; important inorganic and organic structure types. *Prep. 12.843.*

12.852 Ligand Field Theory

Crystal field theory of ions in weak and strong fields. Molecular orbital theory of transition metal complexes. Magnetic properties and electron spin resonance effects. *Prep. 12.843 and 12.886.*

12.861, 12.862 Advanced Organic Chemistry I, II

An intensive survey of organic reactions. Modern concepts of structure and mechanism are used to correlate factual material. *Prep. One year of Organic Chemistry.*

12.863 Physical Organic Chemistry

Topics in basic physical organic chemistry: molecular polarity, equilibrium and kinetics, reactivity and structure, solvent effects, acid-base catalysis, orbital symmetry, aromaticity, etc. *Prep. 12.862 or consent of instructor.*

12.864, 12.865 Stereochemistry I, II

Interrelation of steric arrangements of atoms in organic molecules with their physical and chemical properties. Conformational analysis. Spatial relationships between atoms and groups during chemical reactions and consequent effects on chemical equilibria and reaction rates as an introduction to the study of reaction mechanisms. *Prep. 12.863.*

12.866 Spectrometric Identification of Organic Compounds

Interpretation of the ultraviolet, infrared and nuclear magnetic resonance and mass spectra of organic compounds. *Prep. One year of Organic Chemistry.*

12.867, 12.868, 12.869 Natural Products I, II, III

Isolation, structure determination, synthesis, and transformations of selected classes of organic compounds of biological interest. *Prep. 12.862 (need not be taken in sequence).*

12.871, 12.872, 12.873 Special Topics in Organic Chemistry I, II, III

Selected topics of current importance in organic chemistry. *Prep. 12.862 and consent of instructor.*

12.876, 12.877 Mechanisms of Organic Reactions I, II

Consideration of the fundamental factors influencing the course of a chemical reaction. Utilization of these considerations in the prediction of synthetic applicability of a reaction. *Prep. 12.865.*

12.881 Thermodynamics I

First Law of Thermodynamics, Thermochemistry, Second and Third Laws, Equilibrium. *Prep. Consent of instructor.*

12.882 Thermodynamics II

Partial Molar Properties, Mixtures, E.M.F. *Prep. 12.881.*

12.885 Atomic and Molecular Structure I

Introduction to quantum mechanics. Application to simple systems, and the electronic structure of atoms and molecules. *Prep. One year of Physical Chemistry.*

12.886 Atomic and Molecular Structure II

Atomic spectroscopy. Rotational, vibrational, electronic, and magnetic spectra of small polyatomic molecules. *Prep. 12.885 or consent of the instructor.*

12.891 Special Topics in Physical Chemistry

Selected topics of current importance in physical chemistry. *Prep. Consent of instructor.*

12.892 Selected Topics in Solid State Chemistry

Band theory. Metals, semiconductors and insulators. Thermal, magnetic, and transport properties. Alloy phases. Phase transformations and crystal defects. Surface effects. Material preparation techniques. *Prep. 12.885.*

12.893 Kinetics

Collision and transition state theories of reaction rates. Relaxation theory. Theory of unimolecular reactions. Kinetics in liquid solutions. Photochemistry. *Prep. One year of physical chemistry.*

12.894 Statistical Thermodynamics

Systems of independent particles. Distribution functions. Partition functions and thermodynamic properties. *Prep. 12.881 and 12.885 or their equivalents.*

12.895 Statistical Mechanics I

Quantum statistics; fermions and bosons. Application to electrons in metals, phonons, and photons; superfluidity and superconductivity. *Prep. 12.894.*

12.896 Statistical Mechanics II

Fluctuations, noise, and irreversible thermodynamics. Boltzmann transport equations. Phase transitions of higher order; Ising model. *Prep. 12.895.*

12.897 Quantum Chemistry I

Linear algebra and the formulation of quantum theory. Angular momentum. Systems with spherically symmetric potentials and the one-electron atom. *Prep. 12.886.*

12.898 Quantum Chemistry II

Variational method and perturbation theory. Electron spin. SCF method and many-electron atoms. *Prep. 12.897.*

12.899 Quantum Chemistry III

Group theory. Small molecules. Time-dependent theory and selected advanced topics. *Prep. 12.898.*

12.901 Polymer Chemistry I

Introduction to polymers. Major emphasis on synthesis. Step-reaction, chain-reaction, and ring-opening polymerizations. Copolymerization. Three-dimensional polymers and crosslinking. *Prep. One year of Organic Chemistry and one year of Physical Chemistry.*

12.902 Polymer Chemistry II

Physical chemistry of polymers in solution and bulk. Molecular characterization. Mechanical and physical properties in the glassy, rubbery, viscous, and semi-crystalline states. *Prep. 12.901.*

12.903 Polymer Chemistry III

Industrial practice. Polymer processing. Fibers. Elastomers. Coatings. Adhesives. Reinforced plastics. Relationship of polymer structure to usage. *Prep. 12.902.*

12.910 Special Projects in Chemistry

Laboratory studies on a topic not directly related to research pursued for a thesis. *Prep. Permission of the departmental faculty is required.*

12.990 Seminar (1 q.h.)

Oral reports by the participants on current or recent investigations in chemistry.

12.991 Research and Thesis for M.S. (maximum: 14 q.h.)

Original research and a written thesis thereon, under supervision of a faculty member.

12.995 Research and Dissertation for Ph.D.

Original research in depth, representing a significant contribution of new chemical knowledge, and a written dissertation thereon, under the supervision of a faculty member.

90.821 Biochemistry I

Discussion of the structures and chemistries of carbohydrates, proteins, lipids, nucleic acids, and selected cofactors. *Prep. One year organic chemistry.*

90.822 Biochemistry II

Bioenergetics, enzymes and enzyme kinetics, intermediary metabolism including carbohydrate catabolism, tricarboxylic acid cycle, electron transport, and oxidative phosphorylation. *Prep. Biochemistry I, 90.821.*

90.823 Biochemistry III

Continuation of intermediary metabolism from Biochemistry II, including lipid, protein, and nucleic acid metabolism, photosynthesis and cell regulation. *Prep. Biochemistry II, 90.822.*

See Biology Department offerings and College of Pharmacy offerings for other courses on chemical topics.

clinical chemistry

MASTER OF SCIENCE IN CLINICAL CHEMISTRY

Part-Time Program

Admission

In addition to the admissions requirements listed on page 20, the applicant must have completed a baccalaureate program in biology, chemistry, medical technology, or pharmacy. Undergraduate requirements in this program are a minimum of two quarters of organic chemistry, two quarters of analytical chemistry (each with a laboratory or its equivalent), two quarters of human physiology, and two quarters of physical chemistry. An individual who has deficiencies in any of these areas may take appropriate evening courses at Northeastern University concurrently with those graduate courses which do not require the deficient prerequisites. The appropriate evening courses offered at University College of Northeastern University are: Analytical Chemistry 12.521-6, Organic Chemistry 12.531-3, Physical Chemistry 12.541-3, Human Anatomy and Physiology 18.524-6. Equivalent courses from this university or other universities will be accepted.

Program

The Master of Science in Clinical Chemistry is an interdisciplinary program with the College of Pharmacy and Allied Health Professions. Forty quarter hours of academic coursework are required. In addition, a student must have at least one year of acceptable clinical laboratory experience prior to completion of academic degree requirements. The program is available on a part-time basis with courses offered primarily during the evening hours. Courses are scheduled in the Fall, Winter, Spring, and Summer Quarters. The following are core courses required in the program:

	Total Credits
12.821 Analytical Separations	2
12.823 Optical Methods of Analysis	2
72.834 Clinical Chemistry I	2
72.835 Clinical Chemistry II	2
72.837 Seminar and Report in Clinical Chemistry*	2
73.845 Radioisotopes in Biological Systems	2
87.807 Biometrics	2
87.810 Functions of Human Systems	2
90.821 Biochemistry I	2
90.822 Biochemistry II	2
90.823 Biochemistry III	2
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	22

*The first quarter of 72.837 is a required course. However, the course may be repeated twice as an elective.

Twelve additional credits must be taken from the following elective core courses:

	Credits
12.822 Electroanalytical Chemistry	2
12.824 Special Topics in Analytical Chemistry I	2
12.825 Special Topics in Analytical Chemistry II	2
12.827 Computers in Chemistry	2
12.828 Chemical Instrumentation	2
72.836 Special Topics in Clinical Chemistry	2
72.837 Seminar and Report in Clinical Chemistry	2
72.861 Central Nervous System Depressants	2
72.862 Autonomic Drugs	2
72.863 Anti-infectives	2
72.864 Cancer Therapy	2
72.865 Special Topics in Medicinal Chemistry	2
73.816 Concepts in Toxicology I	2
73.817 Concepts in Toxicology II	2
73.844 Drug Metabolism	2
87.811 Pathophysiology I	2
87.812 Pathophysiology II	2

Taken with the approval of the Admissions Committee and the course instructor, selection may be made from the above courses as well as the following and other appropriate graduate courses in the University.

	Credits
12.841 Inorganic Chemistry I	2
12.842 Inorganic Chemistry II	2
12.846 Coordination Chemistry	2
12.855 Atomic and Molecular Structure I	2
12.861 Advanced Organic Chemistry I	2
12.862 Advanced Organic Chemistry II	2
12.863 Physical Organic Chemistry	2
12.866 Spectrometric Identification of Compounds	2
12.881 Thermodynamics I	2
12.893 Kinetics	2
18.245 Immunology	3
18.840 Comparative Physiology of Regulatory Mechanisms	2
18.842 Vertebrate Endocrinology	2
18.843 Procedures in Endocrinology	3
18.860 Cell Biophysics and Biochemistry	5
18.909 Animal Virology	4
18.940 Microbial Biochemistry	4
72.837 Seminar and Report in Clinical Chemistry	2
73.814 Concepts in Pharmacology I	2
73.815 Concepts in Pharmacology II	2
73.818 Special Topics in Pharmacology	2
73.819 Pharmacological Instrumentation	2
72.866 Phytochemistry	2
87.802 Advanced MLS Hematology and Immunology	2

DESCRIPTION OF COURSES

All courses carry two quarter hours of credit unless otherwise indicated.

Courses with the prefix number 12 are chemistry offerings. Their descriptions may be found in the preceding section of this bulletin along with interdisciplinary biochemistry courses (prefix number 90).

72.834 Clinical Chemistry I

Principles, instrumentation, methodology, and interpretations in clinical chemistry. *Prep. 90.823.*

72.835 Clinical Chemistry II

A Continuation of Clinical Chemistry I. *Prep. 72.834.*

72.836 Special Topics in Clinical Chemistry

Recent advances and techniques in clinical chemistry. *Prep. 72.835.*

72.837 Seminar and Report in Clinical Chemistry

Reports and discussions of current journal articles in clinical chemistry. *Prep. 72.835.*

72.861 Central Nervous System Depressants*

Presentation and discussion of the chemistry, structure-activity relationships, and mechanism of action of general anesthetics, hypnotics and sedatives, anti-epileptics, analgetics, tranquilizers, and muscle relaxants. A consideration of the mechanics of drug design and methods of modification will be undertaken. *Prep. Two quarters of Organic Chemistry, offered alternate years.*

72.862 Autonomic Drugs*

A discussion of drugs acting on the central nervous system with a special emphasis on the mechanism of action of the chemical mediators of the peripheral nervous system. The role of agents affecting this system—adrenergic and cholinergic and reversible and irreversible inhibitors of these systems will be discussed in relation to their chemical structure and biological activity. *Prep. Two semesters of Organic Chemistry. Offered alternate years.*

72.863 Anti-infectives*

A study of the various chemotherapeutic agents employed in the treatment of infectious diseases. Included will be the sulfonamides, antibiotics, antivirals, antitubercular, antifungal, and antimalarial agents. Special emphasis will be on structure-activity relationships, mechanisms of action, and modern research in each area. *Prep. Two quarters of Organic Chemistry. Offered alternate years.*

72.864 Cancer Therapy*

Recent developments in new approaches to the treatment of cancer from a chemotherapeutic standpoint will be considered: including alkylating agents, antimetabolites, hormones, and miscellaneous compounds, and combinations of the above with radiation and immunology. Possible mechanisms of action will be explored. *Prep. Two quarters of Organic Chemistry. Offered alternate years.*

72.865 Special Topics in Medicinal Chemistry*

A consideration of a special area of medicinal chemistry including either CNS compounds, pharmacodynamic agents or chemotherapeutics; their chemistry and structure-activity relationships will be presented. *Prep. Two quarters of Organic Chemistry. Offered alternate years.*

72.866 Phytochemistry*

The important classes of chemical compounds produced by plants considered from the standpoint of their biogenetic origin, methods for their detection, isolation and characterization; application of these techniques to research in pharmacy, medicine, economic botany, taxonomy; and introduction to the literature of plant chemistry. *Prep. Two quarters of Organic Chemistry, two quarters of Biology. Offered alternate years.*

73.816 Concepts in Toxicology I*

Concepts of modern toxicology in which emphasis is placed on biochemical mechanisms underlying the toxicological action of drugs and other chemical substances upon biological systems. Selected topics in toxicology including acute, subacute, and chronic effects of drugs in the experimental animal and man. Consideration of the predictive value of animal studies for drug effects in man. *Prep. Permission of Instructor. Offered alternate years.*

73.817 Concepts in Toxicology II*

Continuation of Concepts in Toxicology I. *Prep. 73.816. Offered alternate years.*

73.844 Drug Metabolism

Presentation of detoxication mechanisms relating to drug metabolism and excretion patterns: adaptive factors influencing metabolism will be discussed. *Prep. Biochemistry I, 90.821.*

73.845 Radioisotopes in Biological Systems

Methodology of radioactive nuclides and application of these isotopes to biology and medicine with special emphasis on their use in clinical analysis.

Other biology, chemistry, and pharmacy courses may be taken with the approval of the admissions committee and the course instructor.

economics

Professors

Morris A. Horowitz, Ph.D.,
Chairman
Harold M. Goldstein, Ph.D.
Irwin L. Herrnsstadt, Ph.D.
Gustav Schachter, Ph.D.
Donald Shelby, Ph.D.

Assistant Professors

Hyun Sik Chung, Ph.D.
Craig Coelen, Ph.D.
Pawan K. Sawhney, Ph.D.
Andrew Sum, M.A.
Steven Swanson, Ph.D.

Associate Professors

Conrad P. Caligaris, Ph.D.
Ernest M. DeCicco, Ph.D.
Daryl A. Hellman, Ph.D.
Sungwoo Kim, Ph.D.
Peggy Musgrave, Ph.D.

The Economics Department offers three terminal programs with different admission requirements and program form and content in an effort to serve students with varying backgrounds, interests, and goals. These programs are: a non-degree certificate program, a master's degree program with specialization in one of four available fields and a doctoral degree program with specialization in the fields of manpower and urban/regional economics.

CERTIFICATE PROGRAM

The Economics Department offers a non-degree program in the Economics of Manpower and Development Planning. Upon completion of the prescribed program, students will receive a certificate issued by the Graduate School of Arts and Sciences, Northeastern University. The program is designed for students interested in a specialized program of courses in manpower and development planning but who do not wish to meet the requirements of a degree program.

Admission

Admission to the program will be considered for graduates of recognized universities or institutes of technology, although practical experience in manpower planning or development planning may be substituted for the admission requirements at the discretion of the faculty. All foreign students must submit a TOEFL test score or an equivalent certification of the applicant's proficiency in English along with the application and academic transcripts.

Program

This certificate program is designed to be completed in one year. Students admitted to the program may not transfer into the regular degree programs. Evidence of completion of a course and of the program shall be attendance, all required reading, and all written work. Successful completion of a course shall be noted by a pass designation.

Fall Quarter (All four courses required)

- 39.9B0 Introductory Macroeconomics
- 39.9A0 Introductory Microeconomics
- 39.9G1 Economics of the Labor Market
- 39.9P1 Economic Development

Winter Quarter (Select any two of three electives listed)

- 39.250 Statistics (Required)
- 39.9G4 Manpower Planning I (Elective)
- 39.9P4 Regional Development (Elective)
- 39.9Q1 Development Finance (Elective)

Spring Quarter (Select any three of four courses listed)

- 39.9J1 Seminar in Human Resource Development
- 39.9R1 Seminar in Development Planning
- 39.9G5 Manpower Planning II
- 39.9P6 Comparative Economic Development

Variations in this basic program are possible only with prior approval of the Graduate Director.

THE MASTER'S DEGREE

Forty quarter hours of academic work are required. This program comprises 16 quarter hours of required core course work and 24 quarter hours of electives of which a minimum of twelve quarter hours must be selected from one of the economic fields listed below. The required core courses must be completed as soon as possible. With the approval of the graduate adviser, a student may select a maximum of six quarter hours from graduate courses offered by other departments, or two advanced undergraduate courses in economics carrying three quarter hours of graduate credit.

Admission

In addition to the requirements listed on page 20, applicants should have had a minimum of 12 semester hours of economics, or the equivalent, of which three semester hours, or the equivalent, should be statistics. Admission is only possible in the Fall and Winter Quarters. Application for admission to the Fall Quarter will be given consideration if received by August 31. Applications for admission to the Winter Quarter will be given consideration if received by November 30.

Applications for financial aid should be submitted no later than March 15. See page 33 for information on financial aid available.

Comprehensive Examination

A comprehensive examination, which will be held in accordance with the general graduate school regulations, must be taken by all students during the quarter in which the student completes the 40 quarter hours of academic work. The examination may be repeated only once.

Master's Thesis

A master's thesis for six quarter hours of credit is optional with the approval of the graduate adviser. Approval will be granted only in those instances in which previous graduate work of the student indicates capacity for independent study.

Required Core Courses

The required core courses are:

	Credits
39.9A1 Microeconomic Theory*	4
39.9B1 Macroeconomic Theory*	4
39.9D1 Mathematics for Economists**	4
39.9E1 Statistical Inference	4

Economic Fields

Available economic fields are listed below. Under each field are stated the required field courses and the elective field courses. Students must take at least twelve quarter hours in one field of concentration. In all fields the first listed required course in the field ordinarily should be taken first by the student majoring in the field. For students not majoring in the field, courses in the field may be taken in any sequence.

Manpower Economics

Required field courses:

- 39.9G1 Economics of the Labor Market and Labor Force
- 39.9G4 Economics of Manpower Planning I
- 39.9J1 Seminar in Human Resource Development

Elective field courses:

- 39.9G5 Economics of Manpower Planning II
- 39.9G7 Public Policy in Manpower
- 39.9H1 Economics of Medical Care and Health Manpower
- 39.9H3 Economics of Education

Urban/Regional Economics

Required field courses:

- 39.9K1 Regional Economics
- 39.9L1 Urban Economics I
- 39.9N1 Seminar in Urban/Regional Economics

* Candidates deficient in intermediate theory may not be admitted into these core courses until they have completed 39.9A0 and/or 39.9B0.

** New candidates must take a mathematics examination given by the department during registration period. Those who fail may not enroll in 39.9D1 until they have completed 39.9D0.

Elective field courses:

- 39.9K5 Economics of Crime
- 39.9L2 Urban Economics II
- 39.9L5 Economics of Urban Transportation
- 39.9L7 Economics of Inter-City Transportation
- 39.9M1 Intergovernmental Fiscal Relations

Development Economics

Required field courses:

- 39.9P1 Economic Development
- 39.9P3 Regional Development
- 39.9R1 Seminar in Development Planning

Elective field courses:

- 39.9P6 Comparative Economic Development
- 39.9Q1 Development Finance
- 39.9G4 Economics of Manpower Planning I
- 39.9K1 Regional Economics

Economics of Money and Finance

Required field courses:

- 39.9S1 Monetary Theory
- 39.9S3 Monetary Policy
- 39.9V1 Seminar in Money and Finance

Elective field courses:

- 39.9T1 Public Policy and Finance
- 39.9T5 Capital Markets
- 39.9Q1 Development Finance
- 39.9M1 Intergovernmental Fiscal Relations

THE DOCTOR OF PHILOSOPHY DEGREE

The doctoral degree program in economics is offered in the fields of manpower economics and urban/regional economics.

Admission

Applicants who will have a master's degree in economics or its equivalent at entry may be considered for direct admission to the doctoral program. Applicants who will not have a master's degree in economics or its equivalent at entry may apply for admission to the doctoral program after the satisfactory completion of 40 quarter hours of graduate work.

Admission to the doctoral program is possible only in the fall term. Applications for the doctoral program must be submitted no later than March 15.

Residence Requirement

After acceptance to the doctoral program, the student may satisfy the residence requirement by one year of full-time graduate work.

Teaching assistants may satisfy the residence requirement by two consecutive years of half-time graduate course work. A student should expect to spend at least two academic years in full-time study, or its equivalent, completing the requirements for the doctoral degree.

Degree Candidacy

Degree candidacy is established in accordance with the general graduate school regulations.

Course Requirements

A. At least 32 quarter hours of graduate work beyond the master's degree will be required. These include:

Required Core Courses:

- 39.9A2 Microeconomics II
- 39.9B2 Macroeconomics II
- 39.9E7 Econometrics I
- 39.9E8 Econometrics II

B. Concentration in the two academic fields of manpower economics and urban/regional economics. Course work in each field must include the doctoral seminars 39.9J3 and 39.9N3. Each of these seminars has a prerequisite of 12 quarter hours of graduate work in the field.

Qualifying Exam

Each student must pass a comprehensive qualifying examination after the completion of the required core and field courses. This comprehensive will be given in parts: (1) A two-hour written exam in each of the general areas of microeconomic theory, macroeconomic theory and quantitative methodology; (2) a three-hour written exam covering the two doctoral fields; (3) A two-hour oral exam covering the two doctoral fields. Passing the qualifying exams signifies that the student has completed all course requirements and can now devote all his time to his dissertation. The examination may be repeated only once.

Doctoral Dissertation

An original doctoral dissertation is required of all students in accordance with the general graduate school regulations and the regulations established by the department. After the successful completion of his qualifying examination, each student shall work with a dissertation adviser under whose guidance he will write his doctoral dissertation. The dissertation adviser serves as chairman of the dissertation committee which must approve the dissertation before the degree may be conferred.

Final Oral Examination

The final oral examination will be established in accordance with the general graduate school regulations.

DESCRIPTION OF COURSES

All courses carry three quarter hours of credit unless otherwise specified.

39.9A0 Introduction to Intermediate Microeconomic Theory

Intensive coverage of microeconomic theory. This course offers no credit toward a degree in economics.

39.9A1 Microeconomic Theory I (4 q.h.)

A non-math treatment of microeconomic theory at the beginning graduate level. An investigation of the conditions underlying consumer and producer equilibrium under different objective functions and various market structures. Derivation of product demand curves, supply curves, and factor demand curves for alternative market structures in product and factor markets are surveyed.

39.9A2 Microeconomic Theory II (4 q.h.)

An examination of contemporary microeconomic problems and theory with specific emphasis on welfare economics, general equilibrium, distribution, the theory of the firm, and the ability of modern value theory to reach meaningful and feasible policy conclusions. *Prep. 39.9A1 and consent of instructor.*

39.9B0 Introduction to Intermediate Macroeconomic Theory

Intensive coverage of macroeconomic theory. *This course offers no credit toward a degree in economics.*

39.9B1 Macroeconomic Theory I (4 q.h.)

Income and employment theory; classical, Keynesian, and post-Keynesian aggregate demand and supply systems.

39.9B2 Macroeconomic Theory II (4 q.h.)

Theory and problems of macro-dynamics, growth, inflation, cycles, and stabilization policy. *Prep. 39.9B1 and consent of instructor.*

39.9D0 Introduction to Mathematics for Economists (4 q.h.)

This course acquaints the student with the algebra and elementary calculus necessary for quantitative economics: simultaneous linear systems; polynomial, logarithmic, and exponential functions; and elementary differential and integral calculus (meets four hours a week). *This course offers no credit toward a degree in economics.*

39.9D1 Mathematics for Economics (4 q.h.)

Application of matrix algebra and simple multivariate calculus to economic analysis. Static organization and dynamic analysis, difference and differential equations. Examples from economic theory. *Prep. 39.9D0 or mathematics examination.*

39.9E1 Statistical Inference (4 q.h.)

Estimation of population values and testing hypotheses. Classical estimation and testing compared to Bayesian Probability. Topics covered include the normal, t , binomial, Poisson, hypergeometric, exponential, X^2 , F , and other probability distributions and the design of sample surveys.

39.9E5 Economic Programming

Economic programming with emphasis on linear programming, including the transportation and simple problems, and simulation and queuing theory with applications to the computer. *Prep. 39.9D1.*

39.9E7 Econometrics I

Review of matrix algebra; single equation least squares estimates and their theoretical properties; hypothesis testing and measures of goodness of fit; definitions of and tests for autocorrelation, heteroskedasticity, and multicollinearity; simultaneous equations estimation: identification, bias, and alternative estimation techniques. *Prep. 39.9D1, 39.9E1.*

39.9E8 Econometrics II

Asymptotic and small sample properties of various estimators; rank-order conditions for identification; specification error and error in variables; remedies for autocorrelation and multicollinearity; dummy variables; distributed lags; forecasting and simulation; non-linear estimation; alternative estimation techniques (two-stage least squares, three-stage least squares, maximum likelihood estimators, etc.). *Prep. 39.9E7.*

39.9I3 Data Processing

A study of digital computers and computer programming techniques. The FORTRAN language is utilized for programming and running several projects.

39.9G1 Economics of the Labor Market and Labor Force

Macro- and micro-analysis of labor supply and demand. Labor force measurement and change. Functioning of labor markets. Labor allocation. Wage and employment determination. Changes in the composition of labor demand. Impact of technological change. Unemployment. Income distribution and poverty. *Prep. 39.9A1 co-requisite.*

39.9G4 Economics of Manpower Planning I

The role of manpower planning and its integration with general development planning. Analysis and evaluation of different techniques of manpower planning. Technological versus economic methods. Practice of manpower forecasting and data problems. Skill training versus educational strategies. Models of educational planning and their applications to different countries. *Prep. 39.9A1 co-requisite.*

39.9G5 Economics of Manpower Planning II

Applications of manpower planning methods and techniques to problems of national economic development. Cost-benefit and cost-effectiveness of educational and manpower programs. Special problems of health manpower, scientists, engineers, and technicians. Evaluation of methods and prediction used in national manpower plans. *Prep. 39.9G4.*

39.9G7 Public Policy in Manpower

Analysis and evaluation of national manpower programs and their implementation on the local level. Relationships between public policy and policies of employers and unions; relationships between programs at different levels of government.

39.9H1 Economics of Medical Care and Health Manpower

The organization of medical care, the problems associated with various alternative delivery systems, the utilization and availability of physicians and other categories of paramedical personnel, the growth and pressures exerted by third party payers; and consideration of federal, state, and municipal participation in the delivery of quality medical care under various alternatives for national health insurance.

39.9H3 Economics of Education

An examination of the contribution of education to the process of economic growth and the way education is produced and distributed. Special topics to include: inequalities in returns to education; the role of intelligence and class background in educational success; and socializing role of education in production.

39.9J1 Seminar in Human Resource Development

Selected topics on the development and use of human resources. *Prep. Consent of instructor.*

39.9J3 Manpower Economics Research Seminar (4 q.h.)

Prep. 12 q.h. of Manpower Economics, and consent of instructor.

39.9K1 Regional Economics

Delineating regions. Theories of location for firms, industries, and people. Regional income accounting systems, and models of intra- and inter-regional income determinants and impact analysis. *Prep. 39.9A1 co-requisite.*

39.9K4 Externalities

Theoretical foundations for urban and regional economics. Survey of economic theory related to externalities and welfare economics. *Prep. 39.9A1 and consent of instructor.*

39.9K5 Economics of Crime

A discussion of the resource allocation problem as it relates to criminal behavior and effective law enforcement. Evaluation of costs and benefits of alternative law enforcement policies. Criminal activity, including organized crime, will be analyzed in an economic context.

39.9L1 Urban Economics I

The economy of cities. Analysis of intra-metropolitan spatial relationships including residential location, land, and housing markets. *Prep. 39.9A1 co-requisite.*

39.9L2 Urban Economics II

Continuation of Urban Economics I. Problems in urban economics including segregation, housing, transportation, urban renewal, and related policy issues. *Prep. 39.9L1.*

39.9L5 Economics of Urban Transportation

Urban agglomeration, economic activities, residential concentration and transportation network; urban and suburban densities in relation to the central place; capital budgeting; pricing; costs incidence and externalities of various modes; cost-benefit analysis; effects of transportation patterns on urban socio-economic life; modal split and forecasting economic requirements for integrated urban transport needs.

39.9L7 Economics of Inter-City Transportation

Investigates the rationale for intercity freight and passenger movements within the framework of interregional commodity flows. The choice of mode once traffic volume has been determined. The economic and environmental impacts of the choice of mode is studied.

39.9M1 Intergovernmental Fiscal Relations

A study of the development of the federal system, interstate and interarea fiscal comparisons, grants-in-aid, tax credits, revenue sharing, state and local taxes, non-tax revenues, borrowing and budgeting at the state and local level, and a discussion of the process and prospects of state and municipal equalization of tax burden and effort. *Prep. 39.9A1.*

39.9N1 Seminar in Urban/Regional Economics

Selected topics in urban/regional economics. *Prep. Consent of instructor.*

39.9N3 Urban/Regional Research Seminar (4 q.h.)

Prep. 12 q.h. of Urban/Regional Economics.

39.9P1 Economic Development

A study of the prospects of economic growth in less developed areas. Measurement and theories of economic development. Role of human and natural resources, education, technology, and capital formation in national, regional, and sectoral development. Changes in institutions.

39.9P3 Regional Development.

Intra-regional dynamics, dualism, and spontaneous polarization. Growth poles, dispersion, and spread effect; inter-regional factor migration and social cost; regional structural change and dynamic analysis; public policies and planning; socio-economic variables and measurements; feasibility and simulation in short-run analysis. Examples of regions at county, province, state and "area" level; differentiation between political and economic boundaries; bootstrapping vs. outside source approach. Application of the FS and UN multiregional models.

39.9P6 Comparative Economic Development

Comparison of economic systems in differing stages of economic development as exemplified by Yugoslavia, Southern Italy, Turkey, the Middle East, and China.

39.9Q1 Development Finance

Resources of investment finance in developing countries; role of taxation and tax structure reform; development of financial institutions and capital markets; private and official finance from abroad and debt-service problems; problems of monetary management and export instability.

39.9R1 Seminar in Development Planning

Planning techniques at the national, regional project and plan level. Planning for system of regions; interindustry economic programming; interdependence, resource use, and structural change. Application of input-output and linear and non-linear optimal decision techniques to short-run planning and long-run projection. Evaluation of discontinuities, linkages, and "openness." Planning in closed and open economy. The role of the private sector and the governments, limits, sequence, and optimality in planning. Application of techniques to empirical examples. *Prep. Consent of instructor.*

39.9S1 Monetary Theory

A study of the relationships between money and economic activity with emphasis upon various quantity theory models and theories of the demand for money and velocity. *Prep. 39.9B1 co-requisite.*

39.9S3 Monetary Policy

A study of the interrelationships between aggregate economic activity, financial markets and central banking instruments, objectives and policy.

39.9T1 Public Policy and Finance

Techniques of fiscal policy, fiscal policy norms, public sector debt; tax policy; federal tax reform; the conflict between social implications of price stabilization and full employment; public expenditure policy and the interrelationship between monetary and fiscal controls. *Prep. 39.9B1 co-requisite.*

39.9T5 Capital Markets

Primary sources of savings and demand for financial assets; role of financial intermediaries; banking system and government lending agencies. Demand for funds and real investment—mortgage, corporate and government securities markets; interdependence of rate structures. Flow of funds data in relation to national income accounts.

39.9V1 Seminar in money, credit, and banking.

Selected topics in the economics of money, credit and banking. *Prep. Consent of instructor.*

39.9Z1 Master's Thesis Seminar (maximum 6 q.h.)

Thesis supervision by members of the department; approval of graduate adviser required.

39.9Z2 Readings in Economics (up to 3 q.h.)

Supervised reading in selected topics in economics. *Prep. Consent of instructor and approval of graduate adviser.*

39.9Z5 Doctoral Dissertation Seminar (no credit)

Prep. Approval of graduate adviser required.

english

Professors

Paul C. Wermuth, Ph.D.,
Chairman
Arthur J. Weitzman, Ph.D.,
Director of Graduate Studies
James T. Barrs, Ph.D. (Emeritus)
Raymond E. Blois, Ph.D.
Victor E. Howes, Ph.D.
Samuel French Morse, Ph.D.
Stanley J. Trachtenberg, Ph.D.

Assistant Professors

Samuel J. Bernstein, Ph.D.
Irene R. Fairley, Ph.D.
Gerald Griffin, Ph.D.
Norma Kroll, Ph.D.
James Nagel, Ph.D.
Donald Roemer, Ph.D.
Joseph E. Westlund, Ph.D.

Associate Professors

Robert J. Blanch, Ph.D.
M. X. Lesser, Ph.D.
Jane A. Nelson, Ph.D.
Robert B. Parker, Ph.D.
Kinley E. Roby, Ph.D.
Herbert L. Sussman, Ph.D.

THE MASTER'S DEGREE

The Department of English offers a program leading to the M.A. degree. The courses emphasize training in research and criticism in the fields of English and American literature, and they provide the student the comprehensive background necessary for a career as a scholar, teacher, and writer.

Admission

Applicants are judged favorably if they do superior work in their undergraduate preparation and do significantly better than average in the verbal and advanced sections of the Graduate Record Examination, the scores of which are required before an application will be considered. An applicant is expected to have had at least 24 semester credits in English beyond the freshman level and have achieved a 3.0 average in English courses on a 4 point scale. Recommendations should be submitted by former English professors. An applicant who is deficient in any one of these areas may be admitted as a provisional student.

The category of special student is provided for those nondegree students who wish to take a summer course or those already enrolled

in a graduate program in another institution who wish to transfer credit. A holder of a graduate degree in English may also enroll as a special student.

Program

Forty-two quarter hours of academic work are required. The course work must include 30.8A1, Bibliography and Literary Historiography, which should be taken as soon as the student enters the program. Required also are three hours from courses in Group II; three hours from courses in Group III; and three hours from courses in Group IV; three hours from courses in Group V (or their equivalents among the seminars); and fifteen hours in designated seminars, which are limited in enrollment to twelve students. The remaining twelve hours may be elected from any courses in the program.

Transfer Credit

A student may transfer from another institution no more than 12 quarter hours (9 semester hours) of graduate credit in English. Within this limit, graduate courses in other fields may also be transferred if their relevance to the student's specialized interest can be demonstrated. In every case, a petition for graduate credit must be sent to the Director of the Graduate School of Arts and Sciences with a copy of an official transcript.

Thesis

A thesis is optional. A student wishing to write a master's paper must secure the approval of a graduate faculty member and write the thesis under the supervision of his adviser. Six credits in lieu of course work are allowed. The student must enroll in 30.9Z1, Thesis, to obtain credit. Papers must conform to the guidelines laid down in the *MLA Style Sheet*.

Comprehensive Examination

A three-hour comprehensive examination is required. It will be given during the Fall and Spring Quarters. Copies of previous examinations are available in the graduate director's office. A student must accrue 30 quarter hours of credit before he is eligible to take the examination. The examination may be taken only twice. As an option, students may choose an oral examination in lieu of the written comprehensive.

Language Requirement

Normally a degree candidate must pass a reading examination in French or German or Latin. Substitutions must have the approval of the graduate director. Exemption from the examination may be obtained by submitting evidence of having passed with at least a grade of C an *advanced* undergraduate language course carrying six credits.

DESCRIPTION OF COURSES

All courses carry three quarter hours of credit unless otherwise specified.

GROUP I

(three quarter hours required)

30.8A1 Bibliography and Literary Historiography

Materials and techniques of research in English and American literature; bibliography, form, and content of papers and theses; problems of literary history.

GROUP II

(three quarter hours required)

30.8B1 Theories of Criticism

Modern critical theories including New Critical, psychoanalytic, and Marxist. *Course may not be used to satisfy group requirement.*

30.8C1 Historical Linguistics I

Written records; the classification of language; phonetics and phonetic change; the comparative method; dialect geography.

30.8C2 Historical Linguistics II

Continuation of 30.8C1. Fluctuation; analogic and semantic change; cultural, intimate, and dialect borrowing. *Prep. 30.8C1.*

30.8C4 Semantics

The relation between language and behavior; the concept of change, variety, and uniqueness; symbols; levels of abstraction; habits of evaluation of linguistic phenomena; and modification of such habits in the direction of human adjustment, understanding, and survival.

30.8C5 History of the English Language I

The nature and origin of language; ancestry and early growth of English; phonetics, sound-change, and history of English sounds; history of English inflections; sources of the vocabulary; the making of words.

30.8C6 History of the English Language II

Semantic change; syntax and usage; dictionaries, spelling, pronunciation, variations, and usage. *Prep. 30.8C5.*

30.8C7 Language and Its Structure

Introduction to the study of language, the principles and methods of linguistic description; the development of the science of language, of descriptive and generative linguistics. Emphasis on goals of modern linguistic theory.

30.8D1 Introduction to Old English

30.8D6 Chaucer's *Troilus* and *Criseyde* and Other Poems

The Book of the Duchess, The House of Fame, and Troilus and Criseyde, with a look at *The Romaunt of the Rose*.

30.8D7 Chaucer's *Canterbury Tales*

GROUP III

(three quarter hours required)

30.8E1 Tudor Literature

Wyatt and Surrey, Sidney, Raleigh and the beginnings of prose fiction.

30.8E4 Renaissance Drama

Twelve representative Elizabethan and Jacobean comedies and tragedies.

30.8F1 Seventeenth-Century Literature

Major prose and poetry of the seventeenth century, excluding drama: Bacon, Hobbes, Browne, Bunyan, Donne, Herbert, Jonson, Marvell, and others.

GROUP IV

(three quarter hours required)

30.8G1 Restoration and Early Eighteenth Century

A critical study of neoclassical drama, poetry, and criticism: Restoration drama, Dryden, and Pope.

30.8G6 Age of Johnson

Johnson, Boswell, and the Club: Burke, Goldsmith, and Gibbon; poetry of Cowper, Gray, and Burns.

30.8H1 Romanticism

General introduction to English Romanticism as an intellectual and artistic movement.

30.8J1 Victorian Literature

General survey touching upon major genres of Victorian literature with emphasis on the transition from the Victorian to the "modern." Such writers as Carlyle, Ruskin, Brontes, Swinburne, Pater, Wilde.

30.8K1 Twentieth-Century British Literature

Theme and structure in the work of several dramatists from Shaw to Osborne and of several novelists from Conrad to Anthony Powell with an emphasis on major trends in the novel and in drama during the present century. *Course may not be used to satisfy group requirement.*

GROUP V

(three quarter hours required)

30.8L1 American Literature to 1830

A survey of American literature during its first two centuries, from the Puritans to the Knickerbockers, from William Bradford to James Fenimore Cooper.

30.8M1 Nineteenth-Century American Literature

A critical examination of the major works of the period including Cooper's *The Pioneers*, Emerson's *Nature*, Thoreau's *Walden*, Hawthorne's *Marble Faun*, Melville's *Moby Dick*, Whitman's *Leaves of Grass*, Twain's *Huckleberry Finn*, Adams's *Education*, and James's *What Maisie Knew*.

30.8N1 Twentieth-Century American Literature

Chance collisions: Adams, Dreiser, Crane, Dos Passos, Fitzgerald, Cozzens, Faulkner. The beginnings and development of Naturalistic fiction.

SEMINARS

(Fifteen quarter hours of seminar courses are required, of which three credits must be in a pre-nineteenth-century period.)

30.9B1 Critical Schools

The subject of this year's seminar will be structuralism and formalism.

30.9B3 English Prose

30.9B4 Short Fiction

The short stories of Sherwood Anderson and Ernest Hemingway and their contribution to American literature.

30.9B5 Comic Drama

The Comic Spirit and its manifestations in dramatic literature and performance. The nature and forms of comic playwriting from Aristophanes to the present. An examination of the theater's comic forms: farce, comedy, satire, parody.

30.9B6 Tragic Drama

This course will consider important theories of tragedy and certain plays in an effort to consider the relation, if any, which exists between theory and practice of the tragic genre.

30.9B7 Theatrical Styles

An examination of modern dramatic expression and theory. The course will give particular attention to absurdist drama, existentialist drama, and Brecht's theatre of alienation.

30.9C1 Phonetics and Dialectology

Mastering of the International Phonetic Alphabet (IPA) and of a standard phonemic alphabet; their application to practical work in recording and studying both standard speech and dialects.

30.9C2 Descriptive Linguistics

Intonation (stress, pitch, juncture); phonemics; morphemes and morphology; syntactic devices; the process of communication; variation in speech; etc.
Prep. 30.9C1.

30.9C5 Transformational and Generative Grammar of English

Deep and surface structures and transformations necessary to generate the latter; graphic representations of structure; deep-structure nature of adjectives, pronouns, prepositions, auxiliaries, possessives, etc.; comparison with traditional grammar.

30.9C7 Linguistics and Literary Study

Formal properties of poetry and prose. Linguistic approaches to problems of style, metaphor, form, and meaning. Contribution of linguistic analysis to literary criticism, and to a theory of literature.

30.9D1 Beowulf

Prep. 30.8D1

30.9D2 Old English Poetry

Prep. 30.8D1

30.9D5 Middle English Lyrics and Drama

A study of the epic and romance, concentrating on the transformation of the epic to the courtly hero: works to include in translation *Beowulf*, *Chretien de Troyes*, the *Nibelungenlied*, and *Le Morte D'Arthur*.

30.9D8 Studies in Fourteenth-Century Literature

Major works in Middle English including *Sir Gawaine and The Green Knight*, *The Pearl*, and *Piers Plowman*.

30.9E1 Studies in Renaissance Poetry

Shakespeare, Marlowe, Jonson *et al.*

30.9E4 Jacobean Drama

About ten plays, mostly tragedies (except for Jonson); the course presumes a knowledge of Shakespeare's late tragedies and romances.

30.9E5 Shakespeare's Histories

The English history plays from *Richard III* to *Henry V*, plus *Titus Andronicus*, *Julius Caesar*, and *Troilus and Cressida*.

30.9E6 Shakespeare's Tragedies

Eight Plays from *Richard II* to *Antony and Cleopatra*.

30.9E7 Shakespeare's Comedies

Eight plays from *Comedy of Errors* to *The Tempest*.

30.9E8 Problems of Shakespearean Interpretation

Present and historical approaches will be considered for the light they shed on several Shakespearean works; a general knowledge of Shakespearean drama and poetry is presumed.

30.9F1 Metaphysical Poetry

Analysis of the structure and texture of poems by Donne, Herbert, and Marvell to determine the distinguishing characteristics of the metaphysical approach to poetry.

30.9F4 Seventeenth-Century Thought

Discussion of seventeenth century theories on science, religion, politics, and art as expressed in Bacon, Burton, Browne, Locke, and Hobbes.

30.9F6 Milton's Major Poetry

Milton's poetic and intellectual achievement will be studied by analyzing his major works. Particular emphasis will be given to *Paradise Lost* as an expression of Renaissance humanism and the culmination of the epic tradition.

30.9G2 Restoration and Eighteenth-Century Drama

Plays of Etherege, Wycherley, Dryden, Vanburgh, Congreve, Gay, Lillo, Goldsmith, and Sheridan.

30.9G5 Intellectual Prose of the Eighteenth-Century

0.9G7 Eighteenth-Century Fiction

Novels by Defoe, Fielding, Richardson, Smollett, Sterne and Austen.

0.9G8 Individual Eighteenth-Century Novelist

Henry Fielding.

0.9H1 Romantic Poetry I

The First Generation: Wordsworth and Coleridge.

0.9H2 Romantic Poetry II

The Second Generation: Byron, Keats, and Shelley.

0.9H3 Problems of Romanticism

Theoretical and historical concepts of Romanticism; defining imagination; the transition to Romanticism; critical readings of the Romantic poets.

0.9H8 Individual Romantic Writer

Blake.

0.9J1 Victorian Poetry I

Close study of Tennyson, Browning, Arnold.

0.9J2 Victorian Poetry II

The Pre-Raphaelite circle, the movement toward modernism: D. G. Rossetti, Swinburne, G. M. Hopkins, Hardy, Wilde.

0.9J5 Intellectual Prose of the Victorian Age

The relation between ideas and literary form in the major works of such writers as Carlyle, Newman, Arnold, Darwin, Ruskin, Pater, Carroll, Wilde.

0.9J7 Victorian Novel

Close study of major works by Dickens, Eliot, the Brontës, Hardy.

0.9J8 Individual Victorian Novelist

Recent critical approaches to the novels of Charles Dickens.

0.9K1 Early Twentieth-Century British Poetry

Twentieth-century poets whose work has shaped the modern tradition, or extended our understanding of the traditions of the past: Hardy, Yeats, Lawrence, Muir, Auden, Owen, Thomas.

0.9K2 Contemporary British Poetry

Graves, Larkin, Hughes, *et al.*

0.9K3 Individual Modern British Poet

W. H. Auden. A study of Auden's achievement as poet, critic, dramatist, and translator, in the context of his age.

0.9K4 Twentieth-Century Irish Renaissance

A study of the emergence of a distinctive Irish literary tradition through concentration on the work of the main figures of the Irish Literary Revival, with particular emphasis on Yeats, Joyce, Synge, and O'Casey; minor concentration will be on post-Revolutionary and contemporary Irish writers: O'Faolain, O'Connor, and Behan.

30.9K7 Twentieth-Century British Fiction

Major figures of the modern and the contemporary periods: Conrad, Joyce Cary, Orwell, Beckett, Compton-Burnett, Braine, Burgess, Fowles.

30.9K8 Individual Modern British Novelist

James Joyce and William Beckett.

30.9L1 Puritanism

Edward Taylor and Jonathan Edwards.

30.9L2 Literature of the New Republic

The beginning of the American literary tradition in poetry, fiction, and drama from Freneau to Cooper, 1765-1830.

30.9M1 Transcendentalism

From religious or metaphysical idealism to theories of self-transformation, with emphasis on Emerson and Thoreau and consideration of related figures such as Kant, Coleridge, Carlyle, William James, Mumford, Jung.

30.9M2 Nineteenth-Century American Poetry

The legacies of Whitman and Dickinson.

30.9M7 The Romance in America

An attempt to define American Romance through the study of Cooper's Leatherstocking novels, the major novels of Hawthorne and Melville's *Moby Dick* and *Billy Budd*.

30.9M8 The Rise of Realism

An examination of Local Colorism, Realism, and Naturalism in the works of Twain, Howells, James, Dreiser, Norris, and readings in European Realism.

30.9N1 Twentieth-Century American Poetry

Twentieth-century poets who have struggled to establish a tradition for American poetry and whose examples have dominated poetry up to the present: Robinson, Frost, Stevens, W. C. Williams, M. Moore, Eliot, Pound, Crane, Cummings, and the Fugitives.

30.9N2 Individual Modern American Poet

Wallace Stevens.

30.9N3 Contemporary American Poetry

Lowell, Bishop, Bronck, Roethke *et al.*

30.9N7 Modern American Novel

Comic Resistance: West, Ellison, Mailer, Hawkes, Barth. The exhaustion of possibilities and the post-modern idea of self.

30.9N8 Individual American Novelist

The Comic Faulkner.

30.9N9 Modern American Drama

Philosophic and aesthetic trends among such playwrights as O'Neill, Williams, Miller, Albee, Simon, and others.

30.9P4 The American 1890s

Intensive study of the works of Stephen Crane with some attention to other writers of the period, including Howells, Frederic, Garland, and to the cultural milieu.

30.9P5 Literature of the American South

A study of the southern literary experience from early nineteenth century to mid-twentieth, from Simms to Faulkner.

30.9P8 Art and Literature in the Victorian Period

Relationships of visual art, literature, and aesthetic theory in the Victorian period. Emphasis on Ruskin, Pre-Raphaelite circle, Pater, Whistler, Wilde.

30.9P9 Twain and James

30.9R1 Creative Writing I

Prose fiction.

30.9R2 Creative Writing II

Prose fiction.

30.9Z1 Thesis (maximum: 6 q.h.)

By arrangement.

30.9Z2 Directed Research

By arrangement.

history

Professors

Raymond H. Robinson, Ph.D.,
Chairman
Philip N. Backstrom, Jr., Ph.D.
Wallace P. Bishop, Ph.D.

Charmarie J. Blaisdell, Ph.D.
Ballard C. Campbell, Ph.D.
William M. Fowler, Ph.D.
Gerald H. Herman, M.A.
John D. Post, Ph.D.
Martin R. Ring, Ph.D.

Associate Professors

Martha E. François, Ph.D.
Norbert L. Fullington, Ph.D.
Donald M. Jacobs, Ph.D.
Stanley R. Stembridge, Ph.D.

Lecturer

Helen S. Frothingham, M.A.

Assistant Professors

Donald R. Allen, Ph.D.

THE MASTER'S DEGREE

Admission

In addition to the admission requirements listed on page 20, applicants must have had a program which includes at least 15 semester hours of history. Applicants for the Fall Quarter who submit their application and all supporting documents by March 15 will be notified on or about April 1. Students who are interested in financial assistance *must* file all material by March 15.

Program

Forty-two quarter hours of academic work are required. Full-time students take four courses each quarter, thereby completing 36 quarter hours during the Fall, Winter, and Spring Quarters. The remaining credits may be taken during the summer sessions preceding or following the normal academic year.

All students must take the following courses:

23.800 Methodology and Theory
either 23.801 European Historiography or 23.900 American Historians

Two courses specifically labeled "seminar," except that students writing theses need take only one seminar.

Students must complete 23.800 prior to enrolling in seminars, and grades of at least B must be obtained in the seminars.

Students must complete at least one course (three quarter hours) in each of three areas: Group I, Europe; Group II, United States; and Group III, Other Regions.

Group requirements will not be satisfied by the historiography courses, 23.801 and 23.900, or by 23.894, 23.895, 23.896, 23.898, and 23.899. Courses are identified by group in the course list below.

With the approval of the faculty adviser, a maximum of nine quarter hours may be elected from graduate courses in other departments and a maximum of 12 quarter hours may be elected from advanced undergraduate courses in history.

A thesis is optional with the approval of the chairman of the department. If approved, a thesis carries nine quarter hours of credit.

In addition to the foregoing program leading to the M.A. in History, there may be other options available: one in American Studies and another in European Studies. Those interested in information about the proposed programs should contact the Department of History.

Comprehensive Examination

All degree candidates must pass a comprehensive examination.

Language Requirement

Proficiency must be demonstrated in a foreign language approved by the department.

Financial Aid

In addition to teaching and tuition assistantships, there is a scholarship in memory of Professor Robert A. Feer who was a member of the Department of History from 1963 to 1970.

DESCRIPTION OF COURSES

All courses carry three quarter hours of credit unless otherwise specified.

23.800 Methodology

The objectives, methods, and resources of the historian.

23.801 European Historiography

The development of historical writing from ancient times to the present.

23.802 Ancient Greece (Group I)

Selected topics in the history of ancient Greece.

23.803 Ancient Rome (Group I)

Selected topics in the history of Rome in the period of the Republic or the Empire.

23.806 Intellectual History of Europe, 1688–1789 (Group I)

The broad spectrum of eighteenth-century thought, with emphasis on scientific, religious, and political ideas.

23.807 Intellectual History of Europe, 1789–1870 (Group I)

The great age of liberal and nationalistic thought. Social problems created by industrialism and various proposals to solve these problems will be examined.

23.808 Intellectual History of Europe, 1870–1950 (Group I)

The intellectual developments which have brought Europe to its present position in world affairs. Topics considered include theories of evolution, scientism, radical socialism, and fascism.

23.809 Seminar in European Intellectual History (Group I)

Research and writing on special topics in European intellectual history.

23.810 Social History of Europe, 400–1350 (Group I)

A study of society in the "Age of Faith," with special emphasis on aspirations, way of life, and cultural achievement.

23.811 Social History of Europe, 1350–1650 (Group I)

A study of social structure, standards of living, aspirations and frustrations, and cultural achievement in an age of Black Death, Renaissance, and religious controversy.

23.812 Social History of Europe, 1650–1850 (Group I)

Exploration of social development and cultural achievement in an age of revolutions — intellectual, political, agricultural, and industrial.

23.813 Economic History of Europe since 1850 (Group I)

Topical analysis of the economic development of modern Europe.

23.817 Medieval Institutions (Group I)

Political, economic, and religious institutions in England and France from the fourth to the thirteenth centuries.

23.818 Seminar in the Renaissance (Group I)

Research and writing concerning the Renaissance.

23.819 Seminar in the Reformation (Group I)

Research and writing concerning the Reformation.

23.820 The Renaissance (Group I)

European political and cultural life from the thirteenth to the seventeenth centuries, with attention to Humanism and to the rebirth of classicism in literature and the arts.

23.821 The Reformation (Group I)

The development of the Christian Church from the thirteenth to the seventeenth centuries, with attention to the conflict between church and state, the impact of the Renaissance, the rise of the Protestant sects, and the wars of religion.

23.822 European Urban History to 1750 (Group I)

A study of urban places from Roman times to 1750 with special consideration of origins; layouts; political, economic, and social life; and the effects of towns on society.

23.823 European Urban History since 1750 (Group I)

A study of urban places since 1750 with attention to the growth of population, industrialization, and bureaucratization and attendant problems.

23.826 English Medieval Constitutional History (Group I)

A study of the traditions and institutions which contributed to the development of common law and parliamentary government from the time of Alfred through the reign of Henry VIII.

23.827 Seminar in England, 1558–1660 (Group I)

A study of political, religious, social, and economic problems from Elizabeth I to the Restoration.

23.830 Britain, 1688–1815 (Group I)

Topics include constitutional evolution, political parties, social and economic change, religious and intellectual developments, cultural achievements, and Scotland and Ireland.

23.831 Britain, 1815–1914 (Group I)

Aspects of nineteenth-century Britain, including reform of parliament, liberalism and socialism, the Irish question, imperialism, and Victorian ideals and attitudes.

23.832 Seminar in Twentieth-Century Britain (Group I)

The seminar will focus on British political parties in the 1930s, with special emphasis on the development of their foreign policies.

23.833 Seminar in Nineteenth-Century Britain (Group I)

Liberalism, conservatism, and the progress of the English people will be the theme of the seminar.

23.835 France, 1180–1661 (Group I)

The history of France from the time of Philip II to the majority of Louis XIV with special emphasis on the problems of cultural, political, and economic unity and the effects of the Renaissance and the Reformation.

23.836 France, 1661–1830 (Group I)

A study of the "Old Regime," including an examination of the reign of Louis XIV, the decline of the French monarchy in the eighteenth century, and the general effects of the Enlightenment; an analysis of the revolutionary period, 1789 to 1830.

23.840 France and Germany, 1870–1918 (Group I)

Selected comparative topics in the Third French Republic and Wilhelmian Germany.

23.841 France and Germany since 1918 (Group I)

Selected comparative topics in French and German history since the First World War.

23.842 Seminar in Modern France (Group I)

Research and writing on a special topic or period in modern French history.

23.845 Seminar in Nineteenth-Century Europe (Group I)

Research and writing in European history from 1850 to 1900.

23.850 Seminar in Russian History (Group I)

A narrow period or special topic in Russian history. *The course presupposes a basic knowledge of Russian history and will require extensive work on a research paper.*

23.855 European Socialist Thought (Group I)

Studies in the history of socialism from the early nineteenth-century utopias to the New Left.

23.860 Diplomatic History of Europe, 1815–1914 (Group I)

The foreign policies of the chief European powers, with emphasis on changing alliances and alignments, imperialistic rivalries, and efforts at international cooperation.

23.862 Twentieth-Century Europe (Group I)

The political history of Europe since 1900, with attention to World War I, the rise of Communism and Fascism, the struggle for security in the western democracies, World War II, and the Cold War.

23.863 Seminar in Twentieth-Century Europe (Group I)

A study of a selected controversy in contemporary European History.

23.870 China to 1800 (Group III)

History of Chinese civilization from antiquity through Confucianism to the period of Western impact.

23.871 Modern China (Group III)

Revolution and institutional change in China from the nineteenth century to 1927.

23.872 Communism in China (Group III)

A study of the Chinese Communist movement from its origins in the 1920s to the present.

23.873 Japan to 1600 (Group III)

A survey of early Japanese history with special emphasis on the social, political, intellectual, and literary history of the medieval period.

23.874 Japan, 1600–1868 (Group III)

A study of the Tokugawa period, emphasizing the problems of late feudal control, urban and rural developments, social, intellectual, and literary history.

23.875 Modern Japan (Group III)

The history of Japan since the fall of the Tokugawa, emphasizing political and economic developments, especially after World War II.

23.881 Modern Africa (Group III)

A topical approach to the history of Africa since 1850.

23.883 History of the Islamic Peoples (Group III)

A study of the history, culture, and religion of the followers of Muhammad from 600 to 1800.

23.884 Modern Middle East (Group III)

A study of the Middle East in the twentieth century.

23.894 Seminar in History and Media

Students will explore such topics as the advantages and drawbacks of specific media, the uses and abuses of media in research and teaching, and the construction of media. Each student will participate in a research project involving the creation and/or evaluation of historically valid films, slide tapes, and other materials.

23.895 Approaches to World History

An interdisciplinary examination of the study of civilization emphasizing various methodologies and theories and testing them by studying specific historical periods and cultures.

23.896 Psycho-History

An introduction to the concepts, scholarship, problems, and directions of psycho-historical studies.

23.898 Population in History

An application of demographic theory to history.

23.899 Studies in Comparative History

The American image in Europe in the nineteenth and twentieth centuries.

23.900 American Historians

The writing of American history by Americans from colonial times to the present with emphasis on changes in both form and substance.

23.901 Recent Interpretations of American History (Group II)

The literature of American history since 1945.

23.905 Colonial America: The Seventeenth Century (Group II)

Exploration of the New World, settlement of the English North American mainland colonies, and the adaptation of European institutions and ideas to New World conditions.

23.906 Colonial and Revolutionary America: The Eighteenth Century (Group II)

The expansion of the English colonies in the New World, the development of political and social institutions, and the sources of friction with England.

23.909 Seminar in Colonial and Revolutionary America (Group II)

Research and writing on some topic in American history prior to 1789.

23.910 American Social History, 1607–1815 (Group II)

The ethnic foundation of American society; the ways Americans made their living, and the ways in which they lived during the colonial and early national periods.

23.911 American Social History, 1815–1900 (Group II)

The King Cotton society of the South, the ferment of reform and industrialism in the North, the Civil War, and the materialistic civilization of the late nineteenth century.

23.912 American Social History, 1900–1950 (Group II)

The transformation of the naive and idealistic America of the early twentieth century to life in a world in which technology has far outstripped man's mental and moral capacity to cope with it.

23.913 American Intellectual History, 1750–1865 (Group II)

American attitudes toward the individual and toward government during the Enlightenment, the romantic movement, and the slavery controversy.

23.914 American Intellectual History since the Civil War (Group II)

The adaptation of the ideas of an agricultural society to the conditions of an urban and industrial society.

23.915 Seminar in American Intellectual History (Group II)

The seminar will focus upon a single figure in American intellectual history. His writings and writings about him will be analyzed.

23.918 Seminar in American Cultural History (Group II)

Research and writing on some aspect of American culture.

23.920 Seminar in American Urban History (Group II)

The political, economic, and social history of America's major cities, with special emphasis on Boston's last century.

23.921 American Social Structure (Group II)

Survey of population, residential, family, ethnic, and class patterns in American history.

23.922 American Immigration and Ethnicity (Group II)

Analysis of immigration to the United States and its impact on American society.

23.924 Topics in American Reform (Group II)

Selected studies of movements to change aspects of American Society.

23.925 Seminar in American Economic History (Group II)

The development of the American economy from 1800 to the present, with special attention to the history of transportation. Topics include the development of highways, canals, railroads, and airlines, with an examination of the roles of private enterprise and government.

23.930 The Westward Movement in the United States in the Nineteenth Century (Group II)

Westward migration into the various geographic provinces will be traced, with emphasis upon its causes, processes, and its economic and political influences. Economic aspects stressed will be those relating to the land: agriculture, mining, lumbering, and grazing.

23.931 Man and Land in the United States in the Twentieth Century (Group II)

Aspects of land use in America since the closing of the frontier, with attention to agriculture and mining and to conservation programs.

23.935 Seminar in Recent American History (Group II)

Special topics from the period 1896 to 1960 will be studied in detail, and students will present a research paper on a major person, action, or movement.

23.937 American Politics, 1800-1877 (Group II)

The development of politics and parties in the nineteenth century.

23.938 American Politics, 1877-1920 (Group II)

Analysis of political patterns in the "transition" period.

23.939 Seminar in American Political History (Group II)

Research and writing on problems in American political history.

23.940 American Politics since 1920 (Group II)

Analysis of recent politics, emphasizing the Presidency, voting behavior, and party activity.

23.941 American Diplomatic History, 1775-1889 (Group II)

The history of American foreign policy and foreign relations from the American Revolution to 1889.

23.942 American Diplomatic History since 1889 (Group II)

The United States in the age of world involvement and responsibility; the imperialistic episode; the world wars; international organizations and alliances.

23.943 Seminar in American Diplomatic History (Group II)

Research and writing on selected topics in the history of American foreign relations.

23.945 Topics in the Civil War and Reconstruction (Group II)

Analysis of key issues surrounding the events leading up to the Civil War, the war itself, and the Reconstruction period.

23.967 Afro-American History I (Group II)

The history of Afro-Americans to 1900, with emphasis on the role of black people in slavery and freedom.

23.968 Afro-American History II (Group II)

The history of Afro-Americans since 1900.

23.969 Seminar in Afro-American History (Group II)

Research and writing on some aspect of Afro-American history.

23.970 The United States and the Caribbean Region (Group II)

The Caribbean policy of the United States from the Monroe Doctrine to the present.

23.971 Mexican History (Group III)

The making of modern Mexico from its Indian and Spanish beginnings to the present.

23.973 South America to 1900 (Group III)

The European impact on South America, the movements for independence, and the nineteenth-century history of the new republics.

23.974 South America since 1900 (Group III)

The internal developments of the South American republics and their relations with one another and with other nations in the twentieth century.

23.975 Seminar in South American History (Group III)

Research and writing on special topics in the history of the South American republics.

23.990 Assigned Reading in History (1 q.h.)

Assigned reading under supervision of a faculty member.

23.991 Thesis (9 q.h.)

Thesis supervision by members of the department.

mathematics

Professors

David I. Epstein, Ph.D.
 Chairman
 Bohumil Cenk, D.Sc.
 Holland C. Filgo, Jr., Ph.D.
 Arshag Hajian, Ph.D.
 Flavio B. Reis, Ph.D.
 Gabriel Stolzenberg, Ph.D.
 Harold L. Stubbs, Ph.D.
 Jack Warga, Ph.D.

Associate Professors

Samuel J. Blank, Ph.D.
 Mark Bridger, Ph.D.
 Alberto R. Galmarino, Ph.D.
 Maurice E. Gilmore, Ph.D.
 Eugene Gover, Ph.D.
 Robert D. Klein, M.S.
 Nancy J. Kopell, Ph.D.
 Richard A. Rasala, Ph.D.
 Thomas O. Sherman, Ph.D.
 Victor R. Staknis, Ph.D.

Assistant Professors

Harriet Fell, Ph.D.
 John Frampton, Ph.D.
 Charles J. Freifeld, Ph.D.
 Nishan Krikorian, Ph.D.
 Jayant Shah, Ph.D.
 Brian Smith, Ph.D.
 Betty Stark, Ph.D.

Instructor

John Casey, B.S.

Admission

In addition to the admission requirements listed on page 19, applicants should have a background which includes courses in linear and modern algebra and mathematical analysis.

THE MASTER'S DEGREE

Full-Time Program

Forty hours of course work are required for the degree. The following courses are required.

	Credits
10.9A1 Basic Analysis and Topology	4
10.9A2 Algebra A	4
10.9A3 Integration	4
10.9A4 Algebra B	4
10.9A5 General Topology	4
10.9A6 Complex Variables	4
10.9A7 Geometry	4
	<hr/> 25

The remaining 12 credits required for the master's degree may be selected from any graduate mathematics courses with the approval of the student's faculty adviser. In some cases, courses in other departments may be approved.

A full-time candidate for the master's degree will normally take the courses listed above in the first four quarters of graduate study, according to the following schedule:

Fall Quarter		Credits	Winter Quarter		Credits
10.9A1	Basic Analysis and		10.9A3	Integration	4
	Topology	4	10.9A5	General Topology ..	4
10.9A2	Algebra A	4			
Spring Quarter		Credits	2nd Fall Quarter		Credits
10.9A4	Algebra B	4	10.9A6	Complex Variables .	4
10.9A7	Geometry	4			

Part-Time Program

Students in this program may progress according to their abilities and the time available. If students are deficient in any of the mathematics courses required for admission to the degree program, they will be required to satisfy their deficiencies by taking courses given for this purpose. Such courses will carry graduate credit, but the credit will be in addition to the regular degree requirements. The following courses are required:

	Total Credits
10.8C1 General Topology I	2
10.8D1, 10.8D2 Theory of Functions of a Real Variable I, II	4
10.8J1, 10.8J2, 10.8J3 Theory of Functions of a Complex Variable I, II, III	6
10.8P1, 10.8P2, Algebra I, II	4
	<hr/> 16

The remaining 24 quarter hours may be selected from graduate mathematics courses. With the approval of the department, a maximum of 10 of these elective credits may be selected from courses in other departments in the Graduate School of Arts and Sciences or the Graduate School of Engineering.

Other Requirements

There is no comprehensive examination and no language requirement for the master's degree. A thesis is not required but may in some cases be substituted for an elective course with the approval of the department.

THE DOCTOR OF PHILOSOPHY DEGREE

Admission

Students who have completed the first year of the full-time master's degree program or who have obtained a master's degree at another

institution are eligible for admission to the doctoral program. A student who wishes to earn the doctor's degree should inform the chairman of the graduate committee of his desire to be a doctoral candidate.

Residence Requirement

The residence requirement is satisfied by one year of full-time graduate work.

Degree Candidacy

Degree candidacy is established in accordance with the general graduate school regulations.

Qualifying Examination

A doctoral candidate will be required to do some sort of independent work during his second year of graduate study (see below). A candidate's performance in course work and in independent work will be used to judge whether he should continue in the doctoral program. After the second year, a student's adviser and the graduate faculty in general will monitor his work. He will be permitted to remain a doctoral candidate as long as his progress is satisfactory.

Course Requirements

The course requirements, in addition to the minimum master's degree requirements of 40 quarter hours of credit, are established by the departmental graduate committee for each candidate. In most cases, 40 quarter hours of additional work will be required.

Independent Work

A doctoral student in his second year of graduate study will be required to do some kind of independent project. The aim of the project is to start a student on independent work and to give him a practical way to learn research techniques. The student should, with the help of his adviser, choose a topic he wants to investigate. In studying his topic a student should read texts and journal articles and learn what to read and what not to read. In addition, he should try to solve problems, compute examples, modify proofs, and see whether or not the known results can be extended. A student should report on his work either in seminars or by giving a special lecture or writing up a short paper. The work of the project can in some cases be done in conjunction with departmental seminars or courses.

Minor Specialty

Each doctoral candidate will select some specific mathematical subject of an advanced nature and by means of reading, lecture courses, and/or seminars master the equivalent of one full year's course work.

in this area. Approval of the area in which the student intends to work should be obtained in advance from the Ph.D. committee. The topic must be reasonably unrelated to that area in which the student plans to write a dissertation.

Language Requirements

Ability to read and translate mathematical texts and journals in two foreign languages must be established by each candidate. The languages may be chosen from French, German, and Russian; any other choice requires special approval. The student should notify the chairman of the departmental graduate committee when he is prepared to be examined on each language. At least one language examination must be passed before beginning work on the dissertation. The examinations are conducted by members of the faculty of the mathematics department.

Teaching Requirement

Some teaching experience is required. This requirement may be satisfied by at least one year of service as a teaching assistant or by suitable teaching duties.

Dissertation

After the successful completion of his independent work, each student shall select a dissertation adviser under whose guidance he will write his doctoral dissertation. If the student wishes it, the departmental graduate committee will assist him in the selection of a dissertation adviser. The dissertation itself must represent an original solution of a problem in the chosen area of mathematics which makes some contribution to mathematical knowledge.

Final Oral Examination

This examination on the dissertation will be held in accordance with the graduate school regulations.

DESCRIPTION OF COURSES

The following courses are offered for those who wish to enter the master's degree program in mathematics, but who fail to satisfy the admission requirements in algebra and/or analysis. These courses will be taken in addition to the required course work in mathematics.

10.8B1, 10.8B2, 10.8B3 Abstract Algebra I, II, III (2 q.h.)

Groups, subgroups, normal subgroups, rings, ideals, integral domains, and fields. *Prep. Differential and Integral Calculus.*

10.8B4 Advanced Calculus I (2 q.h.)

Functions of one independent variable; limits, continuity, differentiability. Properties of continuous functions on a closed bounded interval. Rolle's theorem and the mean-value theorem. *Prep. Differential and Integral Calculus.*

10.8B5 Advanced Calculus II (2 q.h.)

Functions of several independent variables. Distance and open sets; limits, continuity. Properties of continuous functions on a closed bounded set. Differentiability and differentials, mean-value theorem, implicit function theorems, Jacobians and transformations. *Prep. 10.8B4.*

10.8B6 Advanced Calculus III (2 q.h.)

Sequences, sequences of functions, uniform convergence, series. Integration, line and surface integrals. *Prep. 10.8B5.*

The following courses may be used toward the degree requirements in mathematics.

10.8C1, 10.8C2 General Topology I, II (2 q.h.)

Sets and maps, metric spaces, topological spaces, separation axioms, compactness, connectedness. *Prep. 10.8B6 or equivalent.*

10.8D1 Theory of Functions of a Real Variable I (2 q.h.)

Lebesgue measure on real line, measurable functions, Lebesgue integral, convergence theorems, bounded variation, absolute continuity. *Prep. 10.8C1.*

10.8D2 Theory of Functions of a Real Variable II (2 q.h.)

Classical Banach spaces, integration theory on abstract measure spaces, signed measures, Radon-Nikodym theorem, product measure, Fubini theorem. *Prep. 10.8D1.*

10.8E1 Advanced Differential Equations I (2 q.h.)

First order differential equation; existence and uniqueness theorems; dependence of solution on parameter. Stability theory. Periodic solutions. *Prep. 10.8B6.*

10.8E2 Advanced Differential Equations II (2 q.h.)

Systems of first order differential equations. *Prep. 10.8E1.*

10.8E3 Advanced Differential Equations III (2 q.h.)

Selected topics, including asymptotic behavior of solutions. *Prep. 10.8E2.*

10.8E4 Partial Differential Equations I (2 q.h.)

Partial differential equations of first order; Cauchy-problem; Cauchy-Kowalewski theorem. Method of characteristics. *Prep. 10.8B6.*

10.8E5 Partial Differential Equations II (2 q.h.)

Classification of second order equations. Well-posed problems. Emphasis on hyperbolic equations. *Prep. 10.8E4.*

10.8E6 Partial Differential Equations III (2 q.h.)

Emphasis on elliptic equations. *Prep. 10.8E5.*

10.8E7 Nonlinear Differential Equations (2 q.h.)

Nonlinear differential equations of the first order; systems of differential equations; singular points and stability; second-order nonlinear equations; results of Poincaré and Lyapunov; problems in nonlinear mechanics. *Prep. 10.8E3.*

10.8E8, 10.8E9 Integral Equations I, II (2 q.h.)

Equations of Volterra and Fredholm. Symmetric kernels. Orthogonal systems of functions. Applications. *Prep. 10.8B6 or equivalent.*

10.8F1 Difference Equations (2 q.h.)

Formulation and solution of difference equations; approximate solution of engineering problems by finite-difference methods; relaxation techniques; stability and convergence of approximate methods; applications. *Prep. 10.8B6 or equivalent.*

10.8F3, 10.8F4 Calculus of Variations I, II (2 q.h.)

The concept of the first variation of a functional; the simplest variational problem; Euler's equation. Generalization to several variables. Hamilton-Jacobi theory. Sufficient conditions for extrema. Fields of extremals. Direct methods in variational problems. *Prep. 10.8B6.*

10.8G1 Probability I (2 q.h.)

Fundamentals of probability theory; discrete and continuous probability distributions, including binominal, Poisson, and normal; law of large numbers and central limit theorem. *Prep. Differential and Integral Calculus.*

10.8G2 Probability II (2 q.h.)

Further study of probability distributions for one or more random variables. Special topics such as occupancy problems and Markov chains. *Prep. 10.8G1.*

10.8G4 Mathematical Statistics I (2 q.h.)

Fundamental statistical methods. Tests of significance and estimation based on large or small samples; simple correlation and linear regression. *Prep. 10.8G1 or equivalent.*

10.8G5 Mathematics Statistics II (2 q.h.)

Analysis of variance; further topics in statistical inference. *Prep. 10.8G4.*

10.8G6 Estimation Theory I (2 q.h.)

Review of probability with application to multidimensional random vectors. State space approach to dynamic systems with uncertainties. Estimation theory for static and dynamic linear systems based on Bayesian, maximum likelihood, minimum variance, Kalman-Bucy, and weighted least squares methods. Determination of optimal filter, predictor, smoother for discrete linear systems. *Prep. 10.8A4 and 10.8G1.*

10.8G7 Estimation Theory II (2 q.h.)

Determination of optimal filter, predictor, smoother for continuous linear systems. Review of stochastic processes with application to estimation theory. Estimation theory for static and dynamic nonlinear systems. Introduction to hypothesis testing. *Prep. 10.8G6.*

10.8G8 Stochastic Processes I (2 q.h.)

Probability spaces for an infinite family of random variables. Gaussian processes. Processes with independent increments. Strict and wide sense stationary processes. Ergodicity. Random harmonic analysis. *Prep. 10.8G2.*

10.8G9 Stochastic Processes II (2 q.h.)

Markov chains with discrete and continuous time parameter. Markov processes. Counting processes. Renewal processes. Queuing problems. *Prep. 10.8G8.*

10.8J1 Theory of Functions of a Complex Variable I (2 q.h.)

Geometry of the complex plane, analytic functions, Cauchy's theorem. *Prep. 10.8C1 (may be taken concurrently).*

10.8J2 Theory of Functions of a Complex Variable II (2 q.h.)

Infinite sequences and series, singularities, residues, applications. *Prep. 10.8J1*

10.8J3 Theory of Functions of a Complex Variable III (2 q.h.)

Meromorphic functions, Mittag-Leffler theorem, conformal mapping. *Prep. 10.8J2.*

10.8K1 Fundamental Questions of Mathematics: An Introduction to Mathematical Logic (2 q.h.)

A discussion of truth tables, propositional calculus with applications, theories and models, and Godel's incompleteness results. The course stresses the way in which Mathematical Logic raises and solves problems in number theory, set theory, analysis, and geometry. *Prep. none.*

10.8K2 A First Course in Mathematical Logic (2 q.h.)

Propositional calculus, quantificational logic, first order theories through the Skolem-Lowenheim Theorem. *Prep. none.*

10.8K3 An Introduction to Recursive Function Theory (2 q.h.)

Turing machines. Partially computable functions. Primitive recursive and general recursive functions and predicates. Unsolvable decision problems. Recursively enumerable sets of integers. The unsolvability of Hilbert's Tenth Problem. *Prep. none.*

10.8K4 Godel's Incompleteness Theorems (2 q.h.)

Formal number theory. Arithmetization. Godel's First and Second Incompleteness Theorems for formal number theory. *Prep. a knowledge of the methods of mathematical logic.*

10.8K5 Set Theory (2 q.h.)

The informal study of sets, including detailed discussion of the axiom of choice, well-ordered sets, and transfinite arithmetic. *Prep. none.*

10.8K6 Formal Set Theory (2 q.h.)

Versions of axiomatic set theory. The consistency of the continuum hypothesis and the axiom of choice. As time permits, the independence of the continuum hypothesis and the axiom of choice. *Prep. the equivalent of 10.8K2 and 10.8K5*

10.8L1 Numerical Analysis I (2 q.h.)

Solutions of systems of linear algebraic equations by reduction and iterative methods. Solutions of algebraic and transcendental equations. *Prep. 10.8B6 or equivalent.*

10.8L2 Numerical Analysis II (2 q.h.)

Approximation and interpolation. Use of difference techniques in interpolation and quadrature. Approximation by series of orthogonal functions; rational approximation. *Prep. 10.8L1.*

10.8L3 Numerical Analysis III (2 q.h.)

Numerical solution of ordinary and partial difference equations with emphasis on stability and accuracy of solutions. *Prep. 10.8L2.*

10.8L4 Linear Numerical Analysis I (2 q.h.)

Vector space, Jordan canonical form, norms and seminorms, direct solution of linear systems, special systems, error analysis, iterative methods. *Prep. 10.8B1 and 10.8B6.*

10.8L5 Linear Numerical Analysis II (2 q.h.)

Acceleration of iterative methods, the eigenvalue and eigenvector problem. *Prep. 10.8L4.*

10.8L6 Numerical Solution of Partial Differential Equations (2 q.h.)

Applications of linear numerical analysis to the solution of partial differential equations. *Prep. 10.8L5.*

10.8M1, 10.8M2 Approximation Theory I, II (2 q.h.)

Various techniques for the approximation of given functions, including interpolation, rational approximation, and orthogonal functions. Applications to such problems as numerical integration and solution of differential equations. *Prep. 10.8B6.*

10.8M4 Interpolation and Approximation (2 q.h.)

Review of Taylor's theorem, elementary interpolation formulas, difference tables, Newton's formulas, lozenge diagram. Uniform approximation, Weierstrass theorem, Chebychev polynomials. Rational approximation, Padé table, Maehly's methods. *Prep. 10.8B6 or equivalent.*

10.8M5 Approximation and Quadrature (2 q.h.)

Least-squares approximation, orthogonal functions, properties of orthogonal polynomials. Trigonometric approximation, filtering and smoothing. Numerical integration schemes, including Newton-Cotes, Gaussian and Romberg methods. Introduction to Monte Carlo methods and evaluation of higher dimensional integrals. *Prep. 10.8M4.*

10.8M6 Numerical Solution of Ordinary Differential Equations (2 q.h.)

Existence of solutions of differential equations, direction field plots. One-step methods: Euler's method, second-order methods, Runge-Kutta schemes; multi-step methods: predictor-corrector methods, stability, automatic error control, results of Dahlquist, Butcher, Stetter, and Gragg. Higher-order equations and systems of equations. Introduction to boundary-value problems. *Prep. 10.8M5.*

10.8P1, 10.8P2, 10.8P3 Algebra I, II, III (2 q.h.)

The content of these courses is the same as 10.9A2 and the first part of 10.9A4. *Prep. 10.8B2 or equivalent.*

10.8T1 Matrix Analysis I (2 q.h.)

Solutions of systems of linear equations by direct and iterative methods; matrix inversion, characteristic values, canonical forms. *Prep. 10.8B6 or equivalent.*

10.8T2 Matrix Analysis II (2 q.h.)

Discussion of Hermitian, orthogonal, and unitary matrices and their physical significance. Functions of matrices and matrix calculus. *Prep. 10.8T1.*

10.8T3 Tensor Analysis I (2 q.h.)

Tensor algebra; review of three-dimensional point and vector spaces in the setting of tensor analysis. Linear algebra and n -dimensional affine space. The coordinate tensor, tensor products, invariants, physical components. *Prep. 10.8B6 or equivalent.*

10.8T4 Tensor Analysis II (2 q.h.)

Symmetric and alternating tensors, rank and support, duality. The metric tensor. Tensor Calculus: curvilinear coordinates, tangent spaces. *Prep. 10.8T3.*

10.8T5 Tensor Analysis III (2 q.h.)

Tensor fields, covariant derivative. Riemannian geometry, geodesics, curvature tensor. Parallel displacement, linear connections, exterior forms. *Prep. 10.8T4.*

10.9A1 Basic Analysis and Topology (4 q.h.)

Sets and functions. Metric spaces with examples. Continuous functions. Notions of compact, complete, paracompact spaces. Function spaces, especially Banach and Hilbert spaces. Multilinear maps. Coordinate-free calculus, inverse and implicit function theorems, Taylor formula, first-order differential equations.

10.9A2 Algebra A (4 q.h.)

Groups, rings, modules: basic properties and examples. Linear algebra from an advanced standpoint; exactness and techniques of ring theory. Free groups, generators and relations, finitely generated abelian groups, Sylow theorems. Other topics as time permits.

10.9A3 Integration (4 q.h.)

Measure spaces. Abstract Lebesgue integral. Convergence theorems. Construction of Lebesgue measure on \mathbb{R}^n . Radon-Nikodym theorem. Product measure theorem. Fubini's theorem.

10.9A4 Algebra B (4 q.h.)

Polynomial functions and formal polynomials. Polynomial rings and unique factorization. Construction of extension fields. Splitting fields of polynomials. Theory of fields and Galois theory. Examples.

10.9A5 General Topology (4 q.h.)

General topological spaces. Moore-Smith convergence. Compactness and connectedness. Separation properties. Products. Quotient spaces. Inductive and projective limits. Function spaces. Elementary homotopy. Some of the functorial viewpoint.

10.9A6 Complex Variables (4 q.h.)

Elementary properties of holomorphic functions, harmonic functions, maximum modulus principle, approximation theorems, conformal maps, zeroes of holomorphic functions, analytic continuation.

10.9A7 Geometry (4 q.h.)

Fundamental group, covering spaces, simplicial complexes, manifolds, orientation, linear group manifolds. Some attempt to tie up algebra and topology.

10.9B3 Constructive Algebra (4 q.h.)

A constructive development of some of the old familiar areas of algebra: principal ideal domains, Dedekind domains, factorial domains, Noetherian rings.

10.9B9 Seminar: Constructive Analysis (4 q.h.)

Topics in classical mathematics and analysis of them from the constructive standpoint.

10.9C1, 10.9C2 Functional Analysis A, B (4 q.h.)

Topological vector spaces, Banach spaces, Hilbert spaces, algebras of operators, representations.

10.9E1 Advanced Differential Equations (4 q.h.)

The material of 10.8E1 and 10.8E2 is covered as a unit in 10.9E1. *Prep. 10.9A1.*

10.9E3, 10.9E4 Partial Differential Equations A, B (4 q.h.)

Treats a selection of the material of 10.8E4, 10.8E5, and 10.8E6. *Prep. 10.9A1 and 10.9A6.*

10.9E6 Integral Equations (4 q.h.)

Covers material from 10.8E8, 10.8E9. *Prep. 10.9A1.*

10.9G1 Probability (4 q.h.)

Probability spaces. Probability laws of families of random variables. Distribution functions and characteristics functions on \mathbb{R}^n . Strong limit laws of sums of independent random variables. Central limit theorem. Conditional expectations.

10.9H1 Mathematical Statistics (4 q.h.)

This course embodies the material in 10.8G4 and 10.8G5. *Prep. 10.8G1 or equivalent.*

10.9M5, 10.9M6 Lie Groups and Fourier Theory A, B (4 q.h.)

Certain questions in analysis take on a special simplicity due to the benevolent presence of an algebraic structure. Starting with simple classical examples, the course will work toward a deeper and more contemporary vision of Lie groups and Fourier theory. Ideas will outweigh proofs.

10.9N1 Advanced Mathematics A (4 q.h.)

Legendre and Bessel functions, Laplace transforms, Fourier integrals, boundary-value problems, introduction to matrix algebra. *Prep. Differential Equations. Not to be used for credit toward the program in mathematics.*

10.9N2 Advanced Mathematics B (4 q.h.)

This course embodies the material in 10.8A3 and 10.8A4. *Prep. 10.9N1.*
Not to be used for credit toward the program in mathematics.

10.9P0 Seminar: Classical Groups (up to 4 q.h.)

Topics in classical groups as chosen by participants.

10.9P1 Representations of Groups (4 q.h.)

A basic course in group representations and character theory.

10.9Q1 Homological Algebra (4 q.h.)

Maps, sums, tensor products, exact sequences, homology, derived functors and adjoints, applications to algebra and topology.

10.9Q2 Module Theory (4 q.h.)

Techniques of commutative and homological algebra applied to modules and ideals. Applications to regular and Gorenstein rings.

10.9Q6 Ring Theory (4 q.h.)

A survey of ring theory. Commutative algebra and its geometric significance. Ideal and decomposition theory, semi-simple rings. Additional topics to be decided upon.

10.9U1, 10.9U2 Algebraic Topology A, B (4 q.h.)

Topics from: Homology groups, homology sequences, fiber spaces, sheaves, products in homology and cohomology, cohomology algebra, Kunnetheorems, Steenrod operations, Poincare duality, higher homotopy groups and the Hurewicz theorem, characteristic classes.

10.9W1, 10.9W2 Dynamical Systems A, B (4 q.h.)

Structural stability and qualitative theory of dynamical systems.

10.9W9 Seminar: Dynamical Systems (up to 4 q.h.)

Topics in dynamical systems as chosen by participants.

10.9Z1 Master's Thesis (up to 6 q.h.)

10.9Z2 Readings in Analysis (up to 4 q.h. per quarter)

10.9Z3 Readings in Algebra (up to 4 q.h. per quarter)

10.9Z4 Readings in Topology (up to 4 q.h. per quarter)

10.9Z5 Doctoral Dissertation

10.9Z6 Seminar in Analysis (up to 4 q.h. per quarter)

10.9Z7 Seminar in Algebra (up to 4 q.h. per quarter)

10.9Z8 Seminar in Topology (up to 4 q.h. per quarter)

physics

Professors

Roy Weinstein, Ph.D.
Acting Chairman
Ronald Aaron, Ph.D.
Petros N. Argyres, Ph.D.
Richard L. Arnowitt, Ph.D.
Alan H. Cromer, Ph.D.
Marvin H. Friedman, Ph.D.
Marvin W. Gettner, Ph.D.
Michael J. Glaubman, Ph.D.
Bernard Gottschalk, Ph.D.
Walter Hauser, Ph.D.
Giovanni Lanza, Ph.D.
Bertram J. Malenka, Ph.D.
Clive H. Perry, Ph.D.
Eugene J. Saletan, Ph.D.
Carl A. Shiffman, Ph.D.
Yogi N. Srivastava, Ph.D.
Michael T. Vaughn, Ph.D.
Eberhard von Goeler, Ph.D.
Thomas H. Wallace, Ph.D.

Associate Professors

Evangelos M. Anastassakis, Ph.D.
Robert I. Boughton, Ph.D.
David A. Garelick, Ph.D.
Hyman Goldberg, Ph.D.
William L. Faissler, Ph.D.
Robert P. Lowndes, Ph.D.
Pran Nath, Ph.D.
James E. Neighbor, Ph.D.
Jeffrey B. Sokoloff, Ph.D.
Allan Widom, Ph.D.
Fa Yueh, Ph.D.

Assistant Professors

David R. Earles, Ph.D.
Chian-Yuan Young, Ph.D.

Research Associates

Harald Johnstad, Ph.D.
Michael Jordan, Ph.D.
Huan Lee, Ph.D.
Douglas M. Potter, Ph.D.
Giulia Srivastava, Ph.D.
Neal E. Tornberg, Ph.D.

Admission

Applicants for admission must have had, in addition to the requirements of the college, an undergraduate program which includes at least 2 semester hours of upperclass physics (beyond general physics) and courses in calculus and ordinary differential equations.

Students planning to enter graduate school should have in their upper-class undergraduate program the following courses or their equivalent:

11.200 - 11.201 Mechanics
11.211 - 11.212 Electricity and Magnetism
11.220 - 11.230 Thermodynamics, Kinetic Theory and Modern Physics
11.240 - 11.241 Quantum Mechanics

Plus courses in advanced calculus, functions of a complex variable, Fourier series and boundary value problems. (The numbers correspond to Northeastern courses which are listed among the introductory courses below.) Students whose background in one or more of these areas is weak will be asked to satisfy the prerequisites to the required courses by taking up to 9 q.h. of introductory courses.

All students admitted to the program must be interviewed by the department and arrangements for a program of study must be concluded before registration. Appointments may be made in advance (though this is not usually necessary during regular office hours) by writing or calling the department [tel. (617) 437-2902].

The Program

There exists only one graduate program in the department, though some of our students are full-time, some are part-time, some leave with the M.S. and some continue on to the Ph.D.

The department is very active in research as evidenced by a publication rate of over 50 journal articles per year, a research support level of close to \$1 million per year, and an internationally established reputation in experimental and theoretical high energy (particle) and solid state physics. The research done in the department is basic research of high quality, and is of significance to the fundamental development of physics.

THE MASTER OF SCIENCE DEGREE

Course Requirements

Forty-two quarter hours (q.h.) of graduate credit are required, of which up to 12 q.h. may be transfer credit on departmental approval and up to 9 q.h. may be in introductory courses.

The following courses are required, for a total of 30 q.h. of graduate credit:

11.820*, 11.825	Mathematical Methods A,B	(3 q.h.)
11.824, 11.826	Classical Mechanics A,B	(3 q.h.)
11.834, 11.835, 11.836*	Electromagnetic Theory A,B,C	(3 q.h.)
11.841, 11.842, 11.843	Quantum Theory A,B,C	(4 q.h.)

*NOTE: Only one of these two courses is *required* for the M.S.

Students may take as electives any courses carrying graduate credit in physics, mathematics, engineering, chemistry, psychology, or biology, for which the student has adequate preparation.

Detailed course descriptions are listed below.

Sample Programs for Part-time Students

YEAR	F	W	Sp	F	W	Sp	F	W	Sp
I	11.820	11.211	11.212	11.820	11.240	11.241†	11.820†	11.825	11.826
							11.824		
II	11.824	11.825	11.826	11.824	11.825	11.826	11.834	11.835	11.836
III	11.834	11.835	11.836†	11.834	11.835	11.836†	11.841	11.842	11.843†
		11.240			11.285†				
IV	11.841	11.842	11.843	11.841	11.842	11.843	11.827†	11.828†	11.829†

†Electives

THE DOCTOR OF PHILOSOPHY DEGREE

Admission

A student's eligibility to take the Ph.D. qualifying examination is decided by a committee of the department on the basis of the student's overall performance. Full-time students will be notified of their status sometime in their second year of study. Students enrolled in the part-time master's degree program who wish to qualify for Ph.D. candidacy may so indicate by petition to the graduate committee of the department. The petition should include a timetable for completing the additional 33 (30 if he has had 11.836) quarter hours of required courses listed below and for taking the qualifying examination.

THE DOCTOR OF PHILOSOPHY DEGREE

The following courses are required in addition to the required courses for the M.S. degree:

11.827, 11.828, 11.829	Statistical Physics A,B,C	(3 q.h.)
11.836	Electromagnetic Theory C	(3 q.h.)
11.848	Advanced Quantum Theory	(4 q.h.)
11.86A, 11.86B, 11.86C	Particle and Nuclear Physics A, B, C	(3 q.h.)
11.87A, 11.87B	Solid State Physics A,B	(4 q.h.)

Notice that while these courses add up to 33 q.h., 12 q.h. of the total may have been taken for the M.S., leaving only 21 q.h. of additional required courses for the Ph.D.

Sample Programs for Full-Time Ph.D. Students

YEAR	F	W	Sp	F	W	Sp	F	W	Sp
I	11.820	11.211	11.212	11.820	11.240	11.241	11.824	11.825	11.826
	11.824	11.825	11.826	11.824	11.825	11.826	11.834	11.835	11.836
	11.240	11.285†	11.241	11.834	11.835	11.836	11.841	11.842	11.843
II	11.834	11.835	11.836	11.841	11.842	11.843	11.827	11.828	11.829
	11.841	11.842	11.843	11.827	11.828	11.829	11.848	11.87A	11.87B
	11.827	11.828	11.829	Electives			11.86A	11.86B	11.86C
							Qualifying Exam		
III	11.848	11.87A	11.87B	11.848	11.87A	11.87B	Thesis Research		
	11.86A	11.86B	11.86C	11.86A	11.86B	11.86C			
	Electives			Electives					
Qualifying Exam				Qualifying Exam					

IV, V Thesis Research and Advanced Electives

Qualifying Examination

The qualifying examination consists of a written and an oral part. The written examination covers the material in the required courses

†Suggested electives.

for the Ph.D. program. This examination is given twice a year, once in September and once in February. A student must take this examination during the next Fall Quarter following the quarter in which he became eligible to take it. If the examination is failed, it may be repeated for the second and last time on the next occasion it is given.

Residence Requirement

After a student has completed the required 63 q.h. (60 q.h. for students exempted from 11.820) of course work and has passed his qualifying examination, he becomes a doctoral degree candidate and must satisfy the residence requirement by one year of full-time graduate work.

Teaching Requirement

Some teaching experience is required. This requirement may be satisfied by at least one year of service as a teaching assistant or by suitable teaching duties.

Dissertation

The student should arrange for a dissertation adviser by the time he wishes to take the oral part of the qualifying examination. An outline of the dissertation must be approved by the departmental graduate committee at least eight months before the final dissertation examination (see below).

The student may choose his field of research according to one of the following options:

- a) In one of the research areas in the department, under direct supervision of his adviser.
- b) In one of the other research areas of the University, under the direct supervision of a researcher in that field. In that case, a joint committee including his direct supervisor, his departmental adviser, and one other member of the department will constitute his thesis committee.
- c) In an area of applied research in one of the industries or non-profit institutions associated with the department's Industrial Ph.D. Program. His direct supervisor will be an employee of the institution where the research is done (and will have been accredited by the physics department); the rest of the thesis committee will be as in option (b) above.

Final Dissertation Examination

This examination will be held in accordance with the graduate school regulations.

DESCRIPTION OF COURSES

I. INTRODUCTORY COURSES

11.200 Mechanics I (3 q.h.)

Vector analysis. Kinematics and dynamics of particle motion, generalized coordinates and Lagrange's equations of motion. *Prep. Basic Physics and Differential Equations.*

11.201 Mechanics II (3 q.h.)

Conservation theorems, central force motion, systems of particles, rigid body motion, Hamilton's equations. *Prep. 11.200.*

11.208 Introduction to Mathematical Physics

Review of linear algebra and vector calculus, special functions and partial differential equations of physics, potential theory, functions of a complex variable. *Prep. Differential Equations.*

11.211*, 11.212* Electricity and Magnetism I, II (3 q.h.)

A two-quarter sequence in electromagnetic theory, Maxwell's equations and their experimental basis, electrostatics and magnetostatics, the electromagnetic field in empty space, electromagnetic waves, energy and momentum in the electromagnetic field, electrodynamics, the interaction of matter and the field, radiation. *Prep. 11.208.*

11.230 Modern Physics (3 q.h.)

A review of experiments demonstrating the atomic nature of matter, the properties of the electron, the nuclear atom, the wave-particle duality, spin, and the properties of elementary particles. The course discusses, mostly on a phenomenological level, such subjects as atomic and nuclear structure, properties of the solid state, and elementary particles. *Prep. 11.200.*

11.240* Quantum Mechanics I (3 q.h.)

The first of a two-quarter sequence in quantum mechanics. Observations of macroscopic and microscopic bodies. The uncertainty principle, wave particle duality, probability amplitudes, Schrodinger wave theory, and one-dimensional problems. *Prep. 11.208.*

11.241* Quantum Mechanics II (3 q.h.)

Continuation of 11.240. Discrete and continuous states, Schrodinger equation in three dimensions, angular momentum, general theory of quantum mechanics, application. *Prep. 11.240.*

11.285* Introduction to Nuclear Physics (3 q.h.)

Nuclear structure, nuclear masses, radioactivity, nuclear radiation, interaction of radiation and matter, detectors, fission, nuclear forces, elementary particles. *Prep. 11.230.*

11.846, 11.847 Electronics and Data Analysis I, II (4 q.h.)

A two-quarter course intended to teach those electronic and data-analysis techniques that are common to research in all fields of experimental physics.

These courses meet twice a week in the late afternoon or evening for 2 hours each time. The others usually meet 3 times a week in the day (except for 11.871, 11.872).

Subjects in electronics will be: principles of semiconductor devices; analog techniques including feedback and servo loops, and wide-band amplification; digital techniques including integrated circuits and logic techniques; design of electronic subsystems such as counters, analog-to-digital converters and phase-sensitive detectors. Subjects in data analysis will be probability theory; distribution functions; fitting data with a hypothesis; error estimation. Time permitting, high-vacuum techniques, cryogenic techniques, and lasers may also be covered.

11.871 Radiation Physics (2 q.h.)

Introduction to atomic and nuclear physics for graduate students in biology and pharmacy. Topics include quantum mechanics and atomic structure, nuclear structure, radioactivity, properties of nuclear radiation, detection of radiation.

11.872 Radiation Biology and Health Physics (2 q.h.)

The effects of radiation on biological systems and the uses of radiation in medicine and biological research. Topics include dosimetry, effects of radiation on chemical reactions; effects of radiation on cells, organs, and individuals; theories of radiation damage; imaging and tracer techniques using radio-pharmaceuticals; radiation safety and standards. *Prep. 11.871.*

II. REQUIRED REGULAR COURSES (Offered every year)

11.820 Mathematical Methods A (3 q.h.)

Theory of functions of complex variable. Analytic functions. Taylor and Laurent infinite series. Analytic continuation and classification of functions. Calculus of residues. Asymptotic series. Applications to ordinary differential equations and the study of special functions.

11.825 Mathematical Methods B (3 q.h.)

Finite dimensional linear vector spaces. Matrices and determinants. Function spaces, Hilbert space and Hermitian forms. Linear integral equations. Completely continuous operators. Generalized Fourier expansions generated by solutions of the Sturm-Liouville problem. Linear response theory. Green's functions. *Prep. 11.820 or equivalent.*

11.824 Classical Mechanics A (3 q.h.)

Newton's law. Central force motion. Constraints and generalized coordinates. Lagrangian formulation. Hamilton's variational principle. Transformation symmetries. Small oscillations and normal modes. Scattering theory and cross-sections.

11.826 Classical Mechanics B (3 q.h.)

Rigid body motion. Hamiltonian formulation. Poisson brackets and canonical transformations. Hamilton-Jacobi theory. Lagrangian and Hamiltonian formalisms of continuous media and fields. *Prep. 11.824.*

11.827 Statistical Physics A (3 q.h.)

The phenomenological theory of thermodynamics. Fundamental relations and thermodynamic potentials. Extremal principles of thermodynamics. Applications to simple systems. Stability conditions. Phase transitions. Thermodynamics of electric and magnetic systems. Principles of irreversible thermodynamics.

11.828, 11.829 Statistical Physics B, C (3 q.h.)

The principles of statistical mechanics and statistical thermodynamics. Density matrix. Theory of ensembles. Derivation of the laws of thermodynamics. Fermi-

Dirac and Bose-Einstein statistics. Application to gases, liquids, and solids. Theory of phase transitions. Second-quantization formalism for interacting systems. Cooperative phenomena. *Prep. 11.827.*

11.834, 11.835, 11.836 Electromagnetic Theory A, B, C (3 q.h.)

Maxwell's equations. Static field and boundary value problems; multipole expansion. Phenomenology of dielectrics, conductors, and magnetic materials. Faraday's Law. Energy and momentum; Poynting vector; Maxwell stress tensor. Plane waves; polarization. Reflection and refraction; diffraction. Relativity. Radiation from sources. Motion of charged particles in electromagnetic fields; magnetic mirrors, particle accelerators. Introduction to plasma physics; magnetohydrodynamics. Radiation from accelerated charges; bremsstrahlung, synchrotron radiation. Scattering of radiation; interaction of radiation with matter. *Prep. 11.212, 11.820 (concurrently).*

11.841, 11.842, 11.843 Quantum Theory A, B, C (4 q.h.)

Experimental basis of quantum theory. Schrodinger equation and probability interpretation of wave mechanics. Uncertainty principle. Application to one dimensional problems, the harmonic oscillator, orbital angular momentum, and the central force problem. Quantum theory of scattering. Born approximation. Phase shift analysis. Introduction to S-matrix theory. General formulation of quantum mechanics in Hilbert space. Spin. Identical particles and symmetrization principle. Time-independent and time-dependent perturbation theory. Semi-classical theory of radiation and atomic spectra. Addition of angular momentum. Wigner-Eckart theorem. Quantum theory of radiation. Absorption, emission, and scattering of photons. *Prep. 11.240.*

11.848 Advanced Quantum Theory (4 q.h.)

Introduction to the formulation of a relativistic quantum theory. Study of the Dirac equation and its Lorentz covariance. Plane wave solution of the Dirac equation, and projection operators. Bound state solutions of the Dirac equation in a Coulomb field, and the hydrogen atom. Parity, charge conjugation, and time reversal symmetries. Propagator theory. *Prep. 11.843.*

11.86A, 11.86B, 11.86C Particle and Nuclear Physics A, B, C (3 q.h.)

The first quarter is a study of nuclear physics with emphasis on the nature of nuclear forces and its connection to particle physics. Phenomenological models are examined and compared with experimental results. The second and third quarters are a study of elementary particles and their interactions. A basic classification of elementary particles is made, along with a summary of their strong, weak, and electromagnetic interactions. Lorentz invariance and other symmetry principles are used to extract theoretical statements about scattering and decay amplitudes, and particle mass spectra. *Prep. 11.843 and concurrent with 11.848.*

11.87A, 11.87B Solid State Physics A, B (4 q.h.)

Adiabatic approximation and theory of lattice vibrations of perfect crystals. Phonons, polaritons, and their measurement. One-electron approximation of solids and theory of Bloch electrons. Metals, semiconductors, and insulators. Thermal properties. Bloch electrons in external fields. Electron-phonon interaction. Electrical and thermal conductivity. Theory of transport phenomena. Magnetic properties. Amorphous solids. *Prep. 11.827, 11.842.*

III. ADVANCED ELECTIVES**11.804, 11.805, 11.806 Advanced Solid State Physics A, B, C (4 q.h.)**

Selected advanced topics in the theory of solids to be chosen each time by the interested students and instructor. E.g.: Theory of normal metals. Hartree-Fock and Random phase approximations. Optical and transport properties. Solid-phase plasmas. Raman spectroscopy. Quasiparticles and collective excitations. Quantum solids. Amorphous solids, etc. *Prep. 11.829, 11.843, 11.87B.* Offered every other year.

11.857, 11.858, 11.859 Many-Body Theory A, B, C (4 q.h.)

Introduction to some many-body problems and the required mathematical techniques. Theory of linear response and correlation functions. Landau's theory of Fermi liquids and applications to solids. Theory of superconductivity and superfluidity. General theory of Green's functions and diagrammatic techniques. *Prep. 11.829, 11.843, 11.87B.* Offered every other year.

11.854, 11.855, 11.856 Fields, Particles, and Currents A, B, C (4 q.h.)

Introduction to a local field theory. Symmetries of the Lagrangian and conservation laws, Lorentz group, spin, and helicity. P, C, and T. Klein-Gordon, Dirac, vector meson and photon fields. The S-matrix and LSZ reduction formulae. Spectral representations. Feynman diagrams. Green's functions at large Euclidean momenta. Renormalization and finiteness. The renormalization group and asymptotic freedom. Gauge theories, spontaneous breaking and Higgs phenomenon. Weinberg's unified theory of weak and electromagnetic interactions. Currents. *Prep. 11.848.*

11.837 Electromagnetic Theory D (3 q.h.)

Advanced topics in electromagnetic theory such as problems involving radiation reaction, energy, momentum, and the equations of motion of a high-speed particle, Cerenkov radiation, the Lagrangian and Hamiltonian formulation of electromagnetism. *Prep. 11.836.*

11.838, 11.839 General Relativity A, B (3 q.h.)

A brief survey of differential geometry, physical basis of the Einstein equations, simple solutions and experimental tests, cosmology, asymptotic properties of the Einstein equations (radiation, energy, momentum), quantization of the theory. *Prep. 11.837 and 11.826.*

11.91A, B, C (1 q.h.)

11.92A, B, C (2 q.h.)

11.93A, B, C (3 q.h.)

11.94A, B, C (4 q.h.)

Reading course, or theoretical or experimental work under individual faculty supervision. *Prep. Consent of faculty member.*

11.995 Doctoral Dissertation

Experimental and theoretical work for Ph.D. candidates.

political science

Professors

David W. Barkley, M.P.A., Ph.D.
R. Gregg Wilfong, Ph.D.

Associate Professors

George E. Berkley, Ph.D.
L. Gerald Bursey, Ph.D.
Robert L. Cord, Ph.D.
Robert E. Gilbert, Ph.D.
Minton F. Goldman, Ph.D.
Walter S. Jones, Ph.D., Chairman
James A. Medeiros, Ph.D.
David E. Schmitt, Ph.D.
Steve Worth, Ph.D.

Assistant Professors

Dennis R. Goldenson, M.A.
Seth I. Hirshon, Ph.D.
Suzanne Ogden, Ph.D.
Wendell C. Lawther, M.A.

Lecturers

Elizabeth D. Bennett, S.M.
Gordon Bowen, M.B.A.
Thomas J. Cahill, Ph.D.
Ernest W. Cook, Ph.D.
Richard M. Doherty, M.A., J.D.
Kevin T. Fitzpatrick, M.B.A.
W. Arthur Gagne, Jr., S.B., M.B.A.
Richard Gladstone, M.A., M.C.P.
Harry Grossman, L.L.B.
Demeter J. Kollias, M.P.A.
Ronald E. Lawson, M.B.A., M.P.A.
Robert H. McClain, Jr., M.P.A.
Harold J. Mezooff, M.P.A.
Walter W. Mode, M.P.A.
Robert J. M. O'Hare, M.S.
Richard A. Siegel, Ph.D.
Marvin Siflinger, M.P.A.
William A. Sommers, M.P.A.
Wallace Stickney, M.S.
Richard E. Wall, M.A.
John S. Warren, M.P.A.
John A. Wolaver, M.B.A., M.U.A.

Admission

In addition to the admission requirements listed on page 20, applicants for the Master of Arts program should have had a background which includes at least 15 semester hours of political science or government. All applicants must take the Graduate Record Examination.

Applicants for the Master of Public Administration program should demonstrate a clear and strong interest in public administration. All applicants for admission must furnish a statement that supports his or her interest in public administration and provides reasons for wishing to enter this program. Although it is anticipated that most candidates for this program will come with a major concentration in the social sciences, this is not mandatory, and applicants from other fields such as engineering, law, the sciences, and business administration will be considered for candidacy.

THE MASTER OF ARTS DEGREE

Program

Forty-two quarter hours of academic work are required. With the approval of the faculty adviser, a maximum of nine quarter hours may be elected from graduate courses in other departments and a maximum of eight quarter hours may be elected from advanced undergraduate courses.

A thesis is optional with the approval of the chairman of the department. If approved, a thesis carries six quarter hours of credit.

Comprehensive Examination

This examination will be held in accordance with the general graduate school regulations. Every candidate for the degree must pass examinations in two fields as prescribed by the department. Choice may be made from the following fields: American Government, Comparative Government, International Relations, Political Theory, or Public Administration.

THE MASTER OF PUBLIC ADMINISTRATION DEGREE

Program

Forty-two hours of academic work are required. All students must complete the following five courses:

- | | |
|--------|---|
| 22.871 | Public Budgeting |
| 22.872 | Public Fiscal Management, or |
| 22.874 | Functions and Techniques of Public Management |
| 22.880 | Survey of Public Administration |
| 22.882 | Public Personnel Administration |
| 22.885 | Quantitative Methods in Public Administration |

At least five additional courses must be selected from courses designated public administration electives. Not more than four courses may be selected from other graduate courses offered by the department or the University, and these must have the approval of the faculty adviser.

Comprehensive Examination

A candidate for the degree must pass a general examination in the field of public administration as a whole which will test both mastery of the literature and the ability to apply concepts in the field to concrete problems of government.

DESCRIPTION OF COURSES

All courses carry three quarter hours of credit unless otherwise specified.

All courses are seminars.

22.800 American Government

Analysis in depth of selected problems in American government. Examples of problems are: transition of American political parties, legislative reapportionments, and the decline of Congress as a law-making body. *M.P.A. elective.*

22.810 Models of Political Systems.

A detailed examination and critique of current models of political systems.

22.812 Political Psychology and Socialization

An examination of theories of political psychology, opinion formation and attitude change; of political ideology; of processes of individual political development and socialization; of effects on mass and elite political behavior; of attitudinal differences and differential socialization experiences; of individual political behavior and the political system.

22.815 Politics and the Mass Media

Study of the role of mass media in the formation of public opinion, with special attention to use of the media in the electoral process.

22.820 Legislative Process

Study of Congress and of the influence of the President, administrative bureaucracy, parties, interest groups, and public opinion on the development of legislative policy. Comparisons will be made with legislative process in the states.
M.P.A. elective.

22.822 American Constitutional Law

Employing excerpts of U.S. Supreme Court decisions and other primary legal materials, this course examines the constitutional rationale for judicial review; various philosophical approaches to the exercise of judicial power; and the scope of judicial authority to settle questions challenging the legitimacy of governmental actions in the American constitutional system.

22.823 American Constitutional Law II

Using excerpts of primary legal materials, this course builds upon the judicial doctrines developed in 22.822 and specifically examines the constitutional theories behind the growth of congressional prerogatives in economic and social affairs, and expanding presidential power in internal and foreign matters.
Prep. 22.822 or consent of the instructor.

22.824 The Presidency

Examination of the place and function of the chief executive in the formulation and execution of public policy. *M.P.A. elective.*

22.826 American Electoral Behavior

The theoretical and methodological assumptions of election studies of the American political system will be analyzed and the substantive conclusions carefully reviewed.

22.827 Campaigns and Elections.

A study of campaign tactics and strategies. Field Work required.

22.828 The Judiciary

Analysis of the role of the judiciary in the American governmental process. Special attention is given to those areas of constitutional law where the Court's decisions have a profound impact on the basic structure of American politics (apportionment, economic regulation, federalism, etc.).

22.830 Civil Rights

Examination of the doctrine of constitutionalism illustrated and amplified by a study of the substance and process of the Bill of Rights as developed in decisions of Federal courts, and Congressional enactments.

22.831 Procedural Due Process

Utilizing excerpts from U.S. Supreme Court decisions and other legal materials this course examines the philosophical and constitutional relationships between Amendments 4, 5, 6, 8 and the Fourteenth Amendment. The substance of the right to fair trial, counsel, confrontation, protection against self-incrimination and unreasonable searches and seizures are among the many procedural rights examined through the decisions of the Roosevelt, Vinson, Warren, and Burger Courts.

22.832 Intergovernmental Relations

An institutional-behavioral analysis of the changing relationship between the various levels of American government — national, state, and local — relating the pattern of change to the social and economic forces which underlie it. *M.P.A. elective.*

22.834 Constitutional Law

A case development in the basic structural aspects of the American constitutional system including an evaluation of federalism, separation of powers, and the formal and informal processes of amendment and constitutional change.

22.835 Administrative Problems in Criminal Justice

An examination of the criminal justice system in the United States with particular emphasis on political and administrative factors. Emphasis on the role of police, courts, judges, juries, parole, probation and incarceration. *M.P.A. elective.*

22.836 Federal Bureaucracy

Examination of dynamic and structural aspects of the national government, with attention to the place of the national administration in the federal system. *M.P.A. elective.*

22.837 Local Government and the New Federalism

An examination of problems of local government in the light of new patterns of intergovernmental relations. *M.P.A. elective.*

22.838 Bureaucracy and Public Control

An analysis of problems of democratic control in American administration. Topics include technological change, size and complexity, executive-legislative relations, interest groups, and political culture. Stress upon problems for administration in dealing with the multiple pressures of a complex, democratic political system. *M.P.A. elective.*

22.839 Systematic Policy Making

A systematic approach to public policy making, its planning and implementation. Policy making in currently significant subject areas will be discussed and made the basis for illustration of sequential procedures and systems techniques. *M.P.A. elective.*

22.840 Problems in State Government

Appraisal of the problems of contemporary state government in the U.S. Particular emphasis is given to the state government of Massachusetts. Individual research is stressed. *M.P.A. elective.*

22.841 Problems in Urban Planning

An exploration of the devices available to the urban planner for policy implementation, including zoning, subdivision regulation, and capital improvement programs. Special emphasis is given to the planning of individual sites. *M.P.A. elective.*

22.842 Techniques of Urban Planning

A study of the history and techniques of city planning, stressing the elements of planning. *M.P.A. elective.*

22.843 The Politics of Urban Planning

An investigation of the relationships of planning to other governmental functions with stress on practical processes, particularly at the municipal government level. *M.P.A. elective.*

22.844 Urban Government

The contemporary crisis in urban government—problems of political independence, government finance and administration, rapid growth of suburban and metropolitan areas, and decline and decay of the core city are stressed. Particular emphasis is given to the Boston metropolitan area. Individual research is stressed. *M.P.A. elective.*

22.845 Problems of Municipal Administration

Selected case problems and topics in municipal administration including organization, financial management, personnel and labor relations, municipal services, and public and political relations. Individual research is stressed. *M.P.A. elective.*

22.846 Problems of Regional and Urban Development

An examination of the role of government and politics in the planning, programming, and administration of regional and urban development in the United States. Consideration is given to urban renewal; interurban and interregional competition; interstate compacts; public authorities; T.V.A., Appalachia, and New England regional development; anti-poverty programs; and conflicts between public and private interests. Individual research is stressed. *M.P.A. elective.*

22.847 The Politics of Transportation

Examination of the role of politics, governmental mechanisms and public policy in the transportation planning process. Particular attention is given to political interest groups and the manner in which they affect transportation policy on the federal, state and local levels. *M.P.A. elective.*

22.848 Problems of Urban Renewal

Examination of the role of government, politics, and public policy in the urban renewal process and related problems of housing in the United States. *M.P.A. elective.*

22.849 Urban Management and Systems Planning

A non-technical, step-by-step application of systems and computer technology to problems in urban management. *M.P.A. elective.*

22.850 Comparative Politics I

Comparative analysis of politics and political systems with special attention to fundamental problems of theory and practice. The chief focus is on contemporary political systems and contemporary theories in the field of comparative politics. Traditional models are also treated, but more briefly. Particular attention will be paid to British and American political experience.

22.851 Comparative Politics II

Extends and intensifies the comparative analysis of politics undertaken in Comparative Politics I by examining a broader range of institutional experience. Special attention will be given to European political experience, particularly that of France and Germany. *Prep. 22.850.*

22.853 Crisis Politics in Democracies and Dictatorships

Analysis of governmental response to crises and emergencies. Consideration of such topics as war powers, riots and rebellions, martial law, transfer of regime, succession problems, economic crises, presidential emergency powers, national security powers, executive privilege, impeachment, etc.

22.854 Totalitarianism

An analysis of totalitarianism and dictatorship including study of historical background; fundamental characteristics; theories of origin, nature, and significance; and evaluation of techniques, ideologies, policies, and instruments of power. Special attention will be given to the government and politics of the Soviet Union.

22.855 Government and Politics in Germany

A study of political culture, federalism, and executive-legislative relations on the national level with a view to appraising the quality and durability of the present democratic system.

22.856 Government and Politics of France

A study of governmental organization and political behavior in France today. Special attention is given to the role of the presidency, executive-legislative relations, and the political party system.

22.858 Government and Politics of the United Kingdom of Great Britain and Northern Ireland

An analysis of government organization and political behavior in the United Kingdom. Special attention will be given to executive-legislative relations, the political party system, and the politics of Northern Ireland.

22.860 Collective Bargaining in the Public Sector

Study of the mechanisms for labor relations in federal, state and local government with its impact on the public manager. Emphasis is placed upon collective bargaining processes, tactics, and techniques. *M.P.A. elective.*

22.861 Grantsmanship

Instruction in ways to prepare well-conceived, adequately documented, and logically developed grant proposals. Consideration will also be given to the political strategies of proposal submission. *M.P.A. elective.*

22.865 Computer Techniques in Public Administration

Introduces nonspecialists to the uses of computers for management purposes, with special attention to their use in federal, state and local governments. Attention will be given to computer use for planning and problem solving, as well as data processing. *M.P.A. elective.*

22.868 Politics and Health Care Administration

An examination of the politics and administration of health services delivery systems, including a discussion of current topics in health care administration and politics (e.g., national health insurance, health maintenance organizations, physician assistants, citizen participation, administrative decentralization), and an introduction to current developments in policy evaluation methodology and health services research.

22.871 Public Budgeting

Emphasizes the public budgeting function in its relationship to other functions of public administration. Business budgeting in contrast with public, conflicting legislative, and executive interests are examined; illustration is given of the budget cycle and the mechanics of budget preparation; attention is given to means for improving budget decision-making and administration with use of quantitative and other methods.

22.872 Public Fiscal Management

A study of the interrelationships in public administration between systems of finance and the achievement of program objectives. Emphasis is placed upon those aspects of the budgetary process that bear on fiscal policy and appropriations.

22.873 Systematic Analysis and Public Finance

A conceptual examination of the Planning, Programming and Budgeting System (PPBS) and its application to the decision-making and budgetary processes in the public sector. An overview of the elements of the system and their application in determining optimum allocation of public funds. Specific examples will be discussed. *M.P.A. elective.*

22.874 Functions and Techniques of Public Management

An introduction to problems in public management and techniques for dealing with them. This will include functions of middle management, supervision, administration of staff activities (e.g. planning, personnel, budget), organization and methods, public relations, managerial use of computer-based techniques, and tactics and strategies of management.

22.875 Administrative Procedures in Democratic Society**22.876 Administrative Behavior**

An analysis of the sociological and psychological aspects of organization and management. Topics include: bureaucratic leadership; interaction of individual and organization; dynamics of the small group; pathology of bureaucratic behavior. *M.P.A. elective.*

22.877 Public Policy and Environmental Control

Consideration of the legal, political, administrative, and intergovernmental factors involved in the formulation of public policy and the exercise of public power in regulating the use of the environment. Individual research is stressed. *M.P.A. elective.*

22.878 Research in Public Administration

Development and application of research designs in public administration. *M.P.A. elective.*

22.879 Science, Technology, and the Administration of Public Policy

An analysis of central administrative and policy issues raised by the interrelationships of science and public affairs. Some issues to be discussed: effects of technological development upon the development of policy alternatives and their implementation; national policy for support of science and technology; the administrative role of the expert. *M.P.A. elective.*

22.880 Survey of Public Administration

Introduction to the literature and the major topics in public administration with special attention given to the interrelationships of politics and administration.

22.881 Special Issues in Public Personnel Administration

Selected issues and problems will be examined in depth. *Prep. 22.882. M.P.A. elective.*

22.882 Public Personnel Administration

Technique, practice, and organization of personnel functions in public administration, including recruitment, compensation, training, discipline, and relations with employee organizations.

22.883 Comparative Public Administration

A comparative study of the approaches to public administration in selected democratic governments in the United States and Europe. *M.P.A. elective.*

22.884 Comparative Metropolitan Government and Politics

An examination of structure, administration, and politics of selected major European cities in the context of the metropolitan problem in the United States with special emphasis on problem solution and comparative administration. *M.P.A. elective.*

22.885 Quantitative Methods in Public Administration

Application of statistical techniques to Public Administration. *M.P.A. elective.*

22.887 Regionalism and Regional Administration

An examination of the growth and development of intrastate and interstate regional councils, together with their relations with local, state, and federal governments. Examples throughout the nation will be studied, and a detailed analysis made of regional councils in Massachusetts. *M.P.A. elective.*

22.888 Administrative Law

Study of rule-making, adjudication (formal and informal), administrative finality and judicial review, administrative procedure, scope of administrative powers, and enforcement techniques.

22.889 Governmental Accounting

Examination of principles and procedures involved in governmental accounting. *M.P.A. elective.*

22.890 Research Seminar in Public Administration

Will require each student to develop and report upon an individual research project in public administration. This seminar will normally be taken in the last quarter of study for the M.P.A. degree.

22.895 Motivation and Management

An examination of current sociological and psychological theories on the subject of motivations of individuals in organizations and of the effects of their application. *M.P.A. elective.*

22.900 Ancient and Medieval Political Thought

The development of political thought from Greek antiquity to the end of the Middle Ages. Both historical and analytical approaches will be utilized. Attention is also paid to the cultural, social, and intellectual context within which political theories develop.

22.910 Modern Political Thought

Examination of political thought from Machiavelli to Marx.

22.920 Contemporary Political Theory

The main currents of political thought in the latter half of the nineteenth and the twentieth centuries with special emphasis on the relations between political theory, philosophy, and political science.

22.922 The Measurement of Political Events

The purpose of this course is to acquaint political science majors with some analytical and mathematical tools appropriate for use in studying politics.

22.924 Strategy in Politics

An examination of formal theories of political behavior, stressing elements of strategy and their implications. Relationships between political actors, patterns in political processes, bargaining, decision making, and voting will be covered.

22.926 Trends in American Political Thought

Examination of intellectual concepts and movements that have informed and influenced American political life with emphasis upon those relating to the making and execution of public policy. *M.P.A. elective.*

22.928 Organization Theory

An in-depth study of the major organization theories including the scientific basis for organization theory; models and ideal types; decision-making; application of game theory; systems analysis. *M.P.A. elective.*

22.929 Organizational Analysis and Change

A study of the structure and processes of organization essential for problem-solving and for effecting organizational change. Emphasis is placed upon the application of social science theory and administrative principles in administrative problem identification and problem resolution. *M.P.A. elective.*

22.930 Positive Political Theory

An examination of the works of Anthony Downs, William Riker, and others in this current school of political analysis.

22.942 Asia and the Politics of Development

This course relates the theoretical literature on political development to the concrete attempts to develop in Asia. Because of the diversity in levels and types of political development in Asian states, each student is encouraged to concentrate on one state and explore different ideas about political development within the context of that state.

22.943 The Governments and Politics of Latin America

This course investigates contemporary Latin American politics with particular emphasis on militarism, revolution, executive dominance, and social change. It then focuses on three representative nations such as Mexico, Argentina, and Cuba.

22.944 Nationalism

The evolution and role of nationalism in both theory and practice. Representative nationalistic movements and theories are analyzed.

22.946 The Politics of Revolution and Change

Analysis of the nature of political change with attention to both theory and practice. Topics discussed are revolution, major trends in contemporary politics, and the relationship between political change and technological, scientific, or social change.

22.948 Government and Politics of North Africa and the Middle East

Comparative analysis of the political systems and foreign policies of African states north of the Sahara. Also stressed is the relationship of this area with the Middle East.

22.950 United States-Soviet Relations

The relations between the United States and the Soviet Union from 1917 to the present. Topics stressed are: the "nonrecognition" period, the breakdown of the World War II "Grand Alliance," and the nature of the present power conflict.

22.951 United States-Far Eastern Relations

American diplomacy in the Far East, with primary concentration on Japan since World War II, the two Chinas, and Southeast Asia.

22.952 Communist China's Foreign Policy

A study of the Peking government's relations with Afro-Asia, the Soviet orbit, and the West. Attention is given to policy objectives, strategy, tactics, and the method of decision making in both the party and state apparatus.

22.954 Soviet Relations with Eastern Europe

An analysis of Soviet policy in Eastern Europe, especially Russian efforts after World War II to develop communism and maintain a position of pre-eminence in this region.

22.955 Chinese Politics

This course concentrates on the objectives of the Chinese revolution from 1911 to the present. It examines the political theory and institutions which have been established to promote "permanent revolution" and evaluates the "rationality" of Chinese Communist policies in terms of Chinese goals.

22.956 Government and Politics in Sub-Saharan Africa

Comparative analysis of the political systems and foreign policies of selected African states south of the Sahara. Special attention is given to the Republic of South Africa and its policy of apartheid.

22.958 The Formulation and Conduct of American Foreign Policy

The governmental mechanism for foreign policy formulation and its conduct. Problems in decision making and execution are emphasized.

22.959 American Foreign Policy

Examination in depth of selected issues concerning the role of the United States in world affairs since 1945.

22.960 Problems of World Order I

Emphasizes such topics as appraisal of diverse systems of public order, approaches of international law and international organization to the problem of world order, and the problem of world peace enforcement.

22.961 Problems of World Order II

Continuation of 22.960: political problems of world order are stressed. Representative topics considered are arms control, disarmament, strengthening the United Nations, and evaluation of world government proposals. *Prep.* 22.960.

22.964 The United Nations

Selected topics on the "non-political" work of the United Nations: human rights; economic, social, health and related problems; decolonization and the trusteeship system.

22.966 International Law

Examination of selected topics in International Law not covered in 22.960 and 22.961.

22.967 Regional Organization

A study of international organization at the regional level, concerned with examining the capability of institutions to foster integration of policy and authority, and with the effect of this progress upon broader international cooperation.

22.968 The Atlantic Community

A topical analysis of European-American diplomacy from the Marshall Plan to the present, with attention to security matters, United States policy regarding the European integration movement, the Anglo-American "special relationship," the Franco-American discord, and the German dilemma. Continuing focus will be upon Europe as part of the global diplomacy of a superpower as world politics assumes a multipolar configuration.

22.969 The United States and the United Nations

A study of the pursuit of American foreign policy through the United Nations, with emphasis on the uses and effects of parliamentary diplomacy.

22.990 Assigned Reading (maximum: 6 q.h.)

Assigned reading under supervision of a faculty member.

22.991 Thesis (6 q.h.)

Thesis supervision by individual members of the department.

psychology

Professors

John C. Armington, Ph.D.
Harlan Lane, Ph.D., Doc. ès Lettres
Chairman
Helen Mahut, Ph.D.
Bertram Scharf, Ph.D.
Murray Sidman, Ph.D.
Harold S. Zamansky, Ph.D.

Associate Professors

Edward A. Arees, Ph.D.
Roger F. Brightbill, Ph.D.
Perrin S. Cohen, Ph.D.
Charles Karis, Ph.D.
Harry A. Mackay, Ph.D.
Michael Terman, Ph.D.

Assistant Professors

Martin Block, Ph.D.
Karen Busby, Ph.D.
Isaac M. Colbert, Ph.D.
Thomas Corwin, Ph.D.
François Grosjean, Ph.D.
Alexander A. Skavenski, Ph.D.

Senior Research Associates

Leila R. Cohen, Ph.D.
Juan S. Terman, Ph.D.

Research Associates

Matthias Korth, M.D.
Stuart M. Zola, Ph.D.

Admission

In addition to the admission requirements listed on page 20, applicants are expected to have had at least 15 semester hours of psychology, including experimental psychology and statistics. This requirement may be waived in some cases. The Miller Analogies Test is desirable but not required. All application materials must be submitted prior to February 1 of the year in which the applicant plans to begin study. The Graduate Record Examination should be taken by December 15 to insure completion of admissions credentials by February 1.

THE MASTER'S DEGREE

The master's degree is usually taken en route to the Ph.D. Requirements for this degree are 42 quarter hours of academic work including research for six quarter hours of credit, and passing the written qualifying examination as outlined below. The academic work, planned as an integral part of the doctoral program, is outlined on the following pages.

THE DOCTOR OF PHILOSOPHY DEGREE

Residence Requirement

The residence requirement is satisfied by one year of full-time graduate work after admission to doctoral candidacy.

Degree Candidacy

Degree candidacy is established in accordance with the general graduate school regulations.

Qualifying Examination

The qualifying examination consists of evaluation of written materials based upon proseminar discussions.

Course Requirements

A minimum of 27 quarter hours of academic work beyond those required for the master's degree is required. The nature and number of courses must be approved by the adviser and the departmental graduate committee. Approved courses may be taken in other departments.

Dissertation Requirement

A student may start his dissertation during his first year of doctoral work. A dissertation committee will be appointed by the chairman of the department upon the recommendation of the departmental graduate committee. The dissertation committee will be responsible for initial approval of the dissertation in its final form.

Language Requirement

There is no general language requirement, although advisers may recommend preparation of a foreign language by individual students, depending on their specialty areas.

Teaching Requirement

Some teaching experience is required. This requirement may be satisfied by at least one year of service as a teaching assistant or by suitable teaching duties.

Final Oral Examination

The final oral examination is taken after completion of all other requirements for the degree. This examination will not be held until at least two weeks after the dissertation has been accepted by the departmental graduate committee and must be passed at least two weeks before the commencement at which the degree is to be awarded.

The final oral examination will deal with the subject matter of the doctoral dissertation, significant developments in the field of the dissertation, and subject matter as required by the examining committee.

Program

The program will normally be taken in accordance with the following pattern:

FIRST YEAR					
Fall		Credits	Winter		Credits
19.808	Quantitative Methods I	3	19.809	Quantitative Methods II	3
19.817	General Experimental Psychology I . .	4	19.818	General Experimental Psychology II . .	4
19.980	Research Methods I	<u>2</u>	19.981	Research Methods II	<u>2</u>
		9			9
	Spring			Credits	
	19.810	Quantitative Methods III		3	
	19.819	General Experimental Psychology III . .		4	
	19.982	Research Methods III		<u>2</u>	
				9	

SECOND YEAR

Six quarter hours of research and at least 9 quarter hours of electives must be taken during the second year.

All course work beyond the first year is elective and is determined by the student and his adviser with the approval of the graduate committee.

DESCRIPTION OF COURSES

All courses carry three quarter hours of credit unless otherwise specified.

19.807 Mathematical Psychology

Several theories which generate quantitative predictions of behavior are presented.

19.808, 19.809, 19.810 Quantitative Methods I, II, III

A survey of the quantitative methods used in experimental psychology, emphasizing applications of computer programming, theory of functions and relations, curve fitting, probability functions, set theory, and analysis of variance.

19.814 Information-Processing Models in Psychology

Sensory systems considered as information-flow channels, with emphasis on the visual system. Topics to be discussed include: Selection and encoding of sensory information, the effects of neural inhibition and feedback, and applications of linear systems analysis to sensory systems.

19.815 Signal Detection Theory Seminar

This seminar is directed towards the general theory of signal detectability and its application to psychophysical experiments. First, the seminar will consider the general theory of signal detectability at its current state of development. Then, it will consider appropriate procedures for data collection and analysis in order to fit them into the signal detection context.

19.817, 19.818, 19.819 General Experimental Psychology I, II, III (4 q.h.)

The Departmental proseminar. Student presentations and discussions of the experimental literature relating to faculty research interest areas. Includes units on scientific method, learning, sensory processes, physiological variables, personality and developmental variables, and applications of basic research.

19.828, 19.829 Modern Psychophysics I, II

Evaluation and practice of scaling procedures developed by Stevens, and consideration of neuro-physiological evidence supporting the power law.

19.833 Perception

A detailed consideration of research in such areas as form, space and pattern perception, recognition, and the effects of set and motivation on perception. Physiological concomitants of perceptual phenomena will be considered.

19.835, 19.836, 19.837 Learning and Behavioral Analysis I, II, III

These seminars cover contemporary research in operant conditioning, with emphasis on relating the techniques of behavioral analysis to problems of reinforcement, comparative psychophysics, and physiological psychology.

19.838 Human Learning and Cognition

Critical evaluation of current problems in human learning, including concept learning, directed thinking, attention, memory, probability learning, serial and paired-associate learning.

19.844, 19.845, 19.846 Physiological and Comparative Psychology I, II, III

Seminars: a shared background, key concepts, and central issues of the field of physiological and comparative psychology.

19.860, 19.861, 19.862 Vision I, II, III

Seminars: classical and modern problems in vision. Recent journal articles will provide primary source materials for discussion. Consideration will be given to problems of stimulus specification, retinal structure, photochemistry, and psychophysical measures of sensitivity, color vision, and electrophysiology.

19.880, 19.881 Sensory Psychophysiology I, II

Concentration on the anatomy and physiology of the various sensory systems, and correlation of these data with psychophysical and perceptual concepts. Laboratory work will be included.

19.901, 19.902, 19.903 Personality Theory and Research I, II, III

A survey of representative theoretical formulations of the normal personality and its development, and an examination of experimental evidence bearing upon relevant concepts and assumptions (e.g. anxiety, repression, aggression, cognitive styles).

19.808, 19.809, 19.810 Quantitative Methods I, II, III

A survey of the quantitative methods used in experimental psychology, emphasizing applications of computer programming, theory of functions and relations, curve fitting, probability functions, set theory and analysis of variance.

19.912, 19.913, 19.914 Behavior Modification I, II, III

Survey and demonstrations of applied behavior analysis, with emphasis on behavior therapies, retardate training techniques, and classroom behavior modification.

19.980, 19.981, 19.982 Research Methods I, II, III (2 q.h.)

Instrumentation and laboratory techniques through instruction and participation in ongoing laboratory projects.

19.990 Special Topics in Psychology (maximum: 9 q.h.)

19.991 Thesis (6 q.h.)

Experimental work for the master's degree requirement.

19.995 Dissertation

Experimental and theoretical work for Ph.D. candidates.

sociology and anthropology

Professors

Norman Kaplan, Ph.D.,
Chairman
Morris Freilich, Ph.D.
Blanche Geer, Ph.D.
Frank F. Lee, Ph.D.
Morton Rubin, Ph.D.
Earl Rubington, Ph.D.

Associate Professors

M. Catherine Bateson, Ph.D.
Patricia Golden, Ph.D.
Elliott A. Krause, Ph.D.
Lila Leibowitz, Ph.D.
Jack Levin, Ph.D.

Assistant Professors

Marcia Garrett, Ph.D.
Wilfred Holton, Ph.D.
Carol A. Owen, Ph.D.
Alex Rysman, Ph.D.

Admission

The general procedures and requirements are set forth on page 20. Students will normally be admitted to begin their graduate work in the Fall Quarter only. Applications received after March 15 will usually not be considered. Each application will be reviewed on its own merits. Any questions concerning the adequacy of the undergraduate background in sociology or anthropology will be considered individually. In some cases, students may be asked to make up certain deficiencies before proceeding to the basic requirements. Exceptions will be made with respect to procedural or substantive requirements on an individual basis if the circumstances seem sufficiently compelling.

In addition to examining the catalog and course offerings, all prospective candidates are urged to learn something about the scholarly interests and writings of our faculty and to talk with graduate students now in residence to ascertain whether or not we have something to offer in terms of their capabilities, needs, and interests.

NB. Some of the requirements listed below for both the M.A. and Ph.D. will undoubtedly have been modified. Please check with the department and/or the graduate school for the most recent information. This applies also to course offerings.

THE MASTER'S DEGREE

The department offers graduate programs that lead to a master of arts degree in sociology or social anthropology. Forty-two quarter hours of B or better academic work are required for the degree. Certain advanced undergraduate courses offered by the department may be taken for graduate credit with the approval of the department. Students must maintain a better than B average.

In general, students are encouraged to fashion a program of studies best suited to their needs and capabilities instead of following any single set of rigid requirements. To this end, all entering students should consult with members of the faculty and make a tentative choice of faculty adviser before registering for courses.

For the Master of Arts in Sociology, students are generally required to take three quarter courses in theory (usually 21.805, 21.806, and 21.807) and two in methodology (usually 21.810 and 21.811). The statistics requirement may be satisfied by achieving at least a B in 21.814 or its equivalent. All students are strongly advised to take some work in social anthropology.

For the Master of Arts in Social Anthropology, students are generally required to take two quarter courses each in theory (usually 20.801 and 20.802) and methodology. Other requirements will be individually determined. All students are strongly advised to take some work in sociology.

Students who can demonstrate proficiency in any of the requirements need not take those particular courses.

A master's paper is required and earns four quarter hours of credit. This paper may be based on empirical or library research, and must be of publishable quality. It is expected that the full-time student will complete his master's paper no later than the end of his second year. Students planning to go on for the Ph.D. are urged to take the qualifying examination during their second year of residence as the results will be a major determining factor in deciding whether to encourage the student to try to go on or not.

Deadlines for Submission of Master's Paper

A student must have substantially finished his master's paper as certified by his first reader on or before April 1 of the year in which he expects to be awarded the degree. Those who miss the April 1st deadline will normally have to wait until the subsequent fall quarter, and should not expect that a defense can be set up much before November 1st of that quarter.

THE DOCTOR OF PHILOSOPHY DEGREE

The department offers the Ph.D. in sociology. A limited number of students will be enrolled in the Ph.D. program so as to provide highly personalized study and research training with individual supervision.

Admission

Applicants to the doctoral program should apply for admission not later than March fifteenth of the year in which they expect to complete the requirements for the master's degree.

Students seeking admission whose master's degree is not in sociology will be considered on an individual basis. A tentative evaluation of the probability of advanced standing will be made at the time the student is admitted with the final determination after the qualifying examination has been completed.

Students completing their master's at Northeastern will be considered for admission to the doctoral program only after the results of their qualifying examination have been evaluated. Students completing their master's at another institution are admitted with the expectation that they will take the qualifying examination at the first available opportunity.

Residence Requirement

The university's residence requirement can be satisfied by one year of full-time graduate work, or its equivalent, beyond the Master of Arts degree. If the M.A. has not been in sociology, a longer period of residence will undoubtedly be essential. Most students should expect to spend approximately two years or the equivalent in full-time graduate study beyond the requirements of the master's degree.

Degree Candidacy

Degree candidacy is established in accordance with the general regulations of the graduate school.

Qualifying Examination

Students will be examined on their basic knowledge of sociology, especially theory and research methods. The main purpose of this test is diagnostic and should help both the department and the student evaluate strengths and weaknesses and chart a course for the future in the light of these results. Excessive weaknesses and lack of sufficient depth will lead to a recommendation to consider pursuing other alternatives elsewhere.

Students completing their master's work at Northeastern must take the qualifying examination before being admitted to the doctoral program. Students entering the program with a master's degree from another institution should take the qualifying examination at the earliest opportunity after enrolling at Northeastern University.

Course Requirements

Generally, forty-two hours of academic work beyond the master's degree are required. However, the actual number needed by any particular student will be specially determined in each case. Depending on background, experience, and performance, a greater or lesser number of formal courses may be required. Decisions on special cases will be made by the Committee on Graduate Studies (COGS), acting in conjunction with the student, his adviser, and the chairman of the

department. Students entering from another university may be required to take certain basic courses before proceeding with the doctoral program.

Language Requirements

A reading knowledge of French and German is required. Petitions to substitute any other language in which there is substantial sociological literature will be considered. Petition for such substitutions must be submitted for approval to COGS. The language requirements must be satisfied before admission to the comprehensive examination. Statistics and/or advanced mathematics as well as languages needed primarily for field research are considered an integral part of the training of students specializing in such directions, and are therefore not the equivalent of the general language requirement.

Comprehensive Examination

During the period of doctoral degree candidacy, each student must pass a comprehensive examination. This will cover sociology (including theory and methods) and social anthropology. The comprehensive examination must be passed at least nine months before the commencement at which the Ph.D. is to be awarded.

Doctoral Dissertation

The student must submit a prospectus describing the topic of his doctoral dissertation, his methods of research, and the theoretical relevance of his problem. This prospectus is to be discussed with and approved by the dissertation committee consisting of the major adviser, two readers within the department and at least one reader from outside the department. The revised prospectus is then filed with the department.

Deadlines for Considering a Doctoral Dissertation

The chairman of the dissertation committee should be fully satisfied that a dissertation is substantially complete on or before April 1 of the year in which the candidate expects to defend.

Final Oral Examination

The dissertation will be defended after completion of all other requirements for the doctoral degree. This oral defense will be held approximately four weeks after the dissertation has been accepted by the dissertation committee, and at least two weeks before the commencement at which the degree is to be awarded.

NB. Some of the requirements listed above for both the M.A. and Ph.D. will undoubtedly have been modified. Please check with the department and/or the graduate school for the most recent information. This applies also to course offerings.

DESCRIPTION OF COURSES

All courses carry three quarter hours of credit unless otherwise specified.

SOCIAL ANTHROPOLOGY

Many undergraduate courses in the 20.200 series may be offered for graduate credit. Students should check the current course announcements to take advantage of these offerings.

20.801, 20.802 Theory I, II

History of major contemporary orientations: evolutionary approaches, culture area, cultural ecology, functionalism, structuralism, and analysis of current status of these and related theories.

20.805, 20.806 Field Work I, II

Data collection through participant observation and related anthropological methods. Data analysis and reports.

20.815 Tribal Societies and Culture

The structures and institutions of bands, tribes, and chiefdoms: comparative and functional studies of tribal societies and the dynamics of change under contact situations.

20.820 Peasant Society and Culture

Institutions of peasant society. The structure of traditional civilizations and the interrelations between urban and local communities: comparative and functional analysis of the peasant community and the dynamics of change from peasant to post-peasant and industrialized societies.

20.825 Language and Communication

Human communication, including language. Theories of the evolution of language and the application of models derived from the study of language to other aspects of behavior.

20.830 Individual and Culture

Examination of current theory and method in the study of the interplay between personality and culture. Contributions by various disciplines are discussed.

20.835 Kinship and Social Structure

A variety of kinship systems and their terminological and structural components and the way in which their systems articulate with other social institutions.

20.836 Family in Evolutionary Perspective

The emergence of family from pre-human patterns, its biological and behavioral components, and its cross-cultural variations examined from an evolutionary perspective.

20.840 Urban Anthropology

Selected problems in anthropological studies in urban societies.

20.850 Religion and Myth

Nature and institutionalization of primitive, ancient, and contemporary religions. Exploration of religious concepts and movements in relation to social, religious, and political organization.

20.860 Cultural Ecology

Examines man's adaptation to environment and the effect of different human adaptations on natural systems.

20.870 Evolution of Society

The development of political and economic institutions: specialization, social stratification and the emergence of civilization.

20.880, 20.881, 20.882, 20.883, 20.884, 20.885

Ethnographic area courses (India, Africa, Mediterranean and others) will be offered as resources permit.

20.950, 20.951, 20.952 Directed Study in Social Anthropology (maximum: 9 q.h.)

Reading and empirical research in social and cultural anthropology supervised by members of the anthropological staff.

20.980 Contemporary Issues in Social Anthropology

Contemporary issues in the field of anthropology. Supervised readings and written reports on special problems.

20.990 Seminar (maximum: 9 q.h.)

Discussion of selected topics in the field of anthropology.

20.991 Master's Paper in Social Anthropology

Empirical or library research meeting the criteria for publication in a professional journal. *Supervision by members of the department.*

SOCIOLOGY

21.189 Essentials of Statistical Theory

This course reviews concepts essential to an understanding of statistical theory relevant for sociologists. It will include a review of measures of central tendency and dispersion, elementary probability theory, standard probability distributions (Normal, Chi-square, F distribution, student's T distributions, binomial, Poisson, etc.), sampling theory, sampling distribution, and the theory of hypothesis testing. *It may be used to remedy deficiencies in prior statistical training but it does not carry graduate credit.*

21.805, 21.806 Foundations of Social Theory I and II

The classic theorists (Durkheim, Weber, Marx, Simme, and others) will be considered intensively.

21.807 Contemporary Sociological Theories

Analytic treatment of major contemporary theories such as functionalism, conflict, neo-Marxism, and others. *Prep. 21.806.*

21.808 Recent Developments in Sociological Theory

New horizons in theory and the relation of theory to research. Topics to be selected each year and announced by the instructor. *Prep. 21.807.*

21.810 Introduction to Research Methods I

Methods of empirical social research including survey techniques, interviewing, questionnaire construction, sampling procedures, experimental design, and content analysis.

21.811 Introduction to Research Methods II

A continuation of work begun in 21.810. Students will conduct individual research projects.

21.812 Current Issues in Social Research

Selected topics will be examined.

21.813 Statistical Methods for Sociologists

This course is a detailed introduction to statistical methods most relevant to sociology. Topics include tabular analysis, non-parametric statistics, analysis of variance, regression analysis, path analysis, measures of association, estimation and univariate and multivariate hypothesis testing. The approach will presume a knowledge of elementary statistical theory — especially of sampling distribution and the effects of sampling procedure and samples size on their characteristics. Laboratory work including computer processing will be required.

21.814 Mathematical Models and Advanced Statistical Methods for Sociologists

This course will include selected topics in advanced sociological statistics: introduction to Markov chains, factor analysis, multiple classification analysis, and model building. The orientation will be toward the more advanced students and the approach will be somewhat mathematical. Some mathematical aptitude or at least one previous college course in mathematics is suggested. Graduate statistics (21.813) is a prerequisite.

21.817 American Society

Study of the development of and the changes in the institutional structure of American society in comparison with certain other social systems.

21.820 Sociology of Deviant Behavior

Applications of sociological concepts and principles to some problems of social disorganization in industrial societies. Analysis of such problems as suicide, prostitution, physical handicaps, unemployment, alcoholism, sexual deviance, and gambling. *Prep. 21.806.*

21.827 Sociology of Delinquency

Social and psychological factors of delinquency and their implications for prevention, rehabilitation, and treatment.

21.830 Penology and Corrections

Police, court, corrections. The penal system and its treatment methods. Prison. Capital punishment. Probation and conditional sentencing. The inmate society. Parole. After-care. Social consequences of crime.

21.835 Theories of Criminology

Theories and philosophies, underlying various correctional systems. Schools of thought in criminology and penology. Theoretical approaches to the crime and delinquency problem from the beginnings of criminology to current thinking.

21.837 Sociology of Law

Fundamentals of law. The concept of social control. Order and Law. Consensus and conflict. Analysis of the normative-formative influences of law. Mores and morals. The concept of justice. Analysis of some legal institutions.

21.840 Sociology of Medicine

Social aspects of illness and medicine, historically and cross-culturally. Illness and the medical profession in modern society and their structural settings: the community, the hospital, the medical school. Research studies in the field will be examined critically and problems for future research will be specified.

21.843 Sociology of Education

The structure and functioning of educational institutions. Student, faculty, and administrative perspectives. Emphasis will be placed on the role of education in processes of socialization, social mobility, social change, and social control.

21.847 Formal Organizations

Analysis of the goals, functions, and consequences for the individual in modern organizations. Aspects of bureaucratization will be examined within business firms, public institutions, and private associations.

21.850 Sociology of Occupations and Professions

The relations between the occupations and professions and society. Special topics may include occupational stratification, professional group behavior, recruitment and socialization of occupations and professions, and political activism.

21.855 Political Sociology

Sociological analysis of power relations and power systems with special attention to the bases of political power, processes of change in power, and the part played by violence and revolutionary movements.

21.857 Economic Sociology

The role of economic factors in the social process. Consideration will be given to both classic economic theory and its impact on classic social theory, and the potential interrelations between modern economic theory (especially model-building approaches) and general sociological problems.

21.860 Intergroup Relations

The relations between various racial, nationality, cultural, and religious groups with emphasis on historical development. Particular attention will be paid to American society with its specific problems of adjustment and assimilation.

21.863 Sociology of Religion

A sociological analysis of religious institutions and experiences in their historical and contemporary content. Religion and political content will be considered.

21.865 Sociology of Knowledge

The relationship between the social base of a society and its intellectual products. The view points of authors such as Marx, Weber, Mannheim, G. H. Mead, the Neo-Marxian, and other modern schools will be considered. *Prep. Three terms of graduate theory.*

21.870 The Family

Social structure and social functions of the family as a social institution. Relations between the family and other institutions in society will be examined comparatively and historically.

21.873, 21.874 Childhood and Adolescence I, II

Growth and development of the child in the social context. Primary socialization in the family including the transmission of role expectations, values, and the development of self concept. Secondary group socialization in school, neighborhood, and peer group.

21.877 Theories of Socialization

A critical examination of the major theories in the field. Attention will be focused on the work of Freud, Piaget, Cooley, Mead, Parsons, and Merton.

21.880 Community Analysis

Ecological theories of man's relation to his physical environment. Development of the concept, and discussion of methods for community study. Comparison between rural communities and urban neighborhoods. Discussion and evaluation of community action programs.

21.881 Community Research Lab.

21.885 Urban Sociology

Theories of the development of urban life. Comparisons between pre-industrial and industrializing urban areas. Methods for the study of urban social structure and change. Evaluation of contemporary metropolitan action programs.

21.886 Seminar in Urban Social Research Policies

Social science theories and methods are evaluated from the perspectives of urban affairs research. *Consent of instructor.*

21.890 Middle East Area Study

Socio-cultural analysis of the Middle East. Ecological, structural, institutional, and normative factors in nomadic, rural, and urban life. Comparative regional analysis.

21.895 Latin American Societies

Study and analysis of selected Latin American societies with particular attention to such countries as Cuba, Mexico, Peru, and Brazil. Emphasis on urbanization and industrialization, social and political change.

21.900 Issues in Social Psychology

Human behavior and theories of self from a sociological and psychological perspective. Special consideration of interpersonal relations, socialization, and symbolic interaction.

21.910 The Sociology of Science

Selected topics dealing with interactions between science and society. *Consent of instructor.*

21.912, 21.913 Experimental Methods in Social Research I, II

This course covers experimental design and laboratory methods in sociology. The small groups laboratory is treated as a setting for testing sociological theory.

The emphasis is upon techniques and problems in the creation and manipulation of social variables in the laboratory situation, although the techniques of the natural experiment are also considered.

21.915 Seminar in Symbolic Interaction

The social psychology of groups as found in the works of Mead, Becker, Blumer, Goffman, and others.

21.916, 21.917 Seminar in Qualitative Analysis I, II

First Quarter: Social Structure process and meaning in interacting groups. Each student studies a face-to-face group by means of participant observation using symbolic interaction concepts. **Second Quarter:** Situational analysis of field data. The relation of method and theory.

21.920 Social Stratification

Theories of inequality between groups in historical perspective, from classical to modern industrial times. Discussion and evaluation of sociological research in social stratification in regard to different social and cultural groups.

21.930, 20.930 Social and Cultural Change S, A

Two-quarter course, in conjunction with Anthropology.

Analysis of the changing patterns in social, economic, and political institutions. Modern social trends are discussed.

21.940, 21.941 Social Control I, II

Seminar in research, theories, and methods in the sociology of social control.

21.950, 21.951 Seminar in Social Structure I, II

Seminar relating current theories and research in sociology, social psychology, and social anthropology.

21.960, 21.961, 21.962 Seminar on Socialization I, II, III

I. Instructor reviews theories and findings in organizational socialization. II. Students design studies in organizational socialization. III. Students present results of their studies. *Not open to first year students.*

21.980 Contemporary Issues in Sociology

Contemporary issues in sociology. Supervised readings and written reports on special problems.

21.990 Seminar (maximum: 9 q.h.)

Discussion of selected topics in the field of sociology.

21.991 Master's Paper in Sociology

Supervision by members of the department. Empirical or library research meeting the criteria for publication in a professional journal.

21.992, 21.993, 21.994 Directed Study in Sociology (Maximum: 9 q.h.)

Reading and research under the direction of a faculty member. *Open to doctoral candidates with the consent of the graduate committee.*

21.995 Doctoral Dissertation

index

A

Academic calendar, 4
Address of University, 1
Administration
 University, 8-10
 Graduate, 11
Admission (see also Courses), 20
 Doctor's degree, 24-27
 Master's degree, 23-24
Applications, 19
Assistantships, 29

B

Biology, 32
 Courses, 36-43
 Faculty, 32
 Programs, 32-36
Board of Trustees, 7
Buildings, 17-18

C

Calendar, 4
Campus description and location, 17
 Map, 2
Center for Continuing Education, 16
Chemistry, 44
 Courses, 47-50
 Faculty, 44
 Programs, 44-46
Clinical Chemistry, 51
 Program, 51-52
 Courses, 53-54
Class hours, 22
Committee of the Graduate School of
 Arts and Sciences, 14
Cooperative Plan of Education, 15
 (see also Courses)
Corporation, 6-8
Courses
 Anthropology (see Sociology)
 Biology, 32
 Chemistry, 44
 Clinical Chemistry, 51
 Economics, 55
 English, 65
 History, 74
 Mathematics, 82
 Physics, 93
 Political Science, 101

Psychology, 112
Sociology, 117

Credits, 22

D

Degree programs, 23-27
 (see also Courses)
Doctor of Philosophy degree
 Admission, 25
 Comprehensive examination, 25
 Course requirements, 25
 Dissertation, 25
 Final oral examination, 25
 Foreign language, 25
 Interdisciplinary programs, 26-27
 Qualifying examination, 25
 Registration, 26
 Residence requirement, 25
 Time limitation, 24
 Transfer credit, 24

E

Economics, 55
 Courses, 60-64
 Faculty, 55
 Programs, 55-59
English, 65
 Courses, 67-73
 Faculty, 65
 Program, 65-66
Evening programs (see Courses)
Executive Council, 10

F

Fees, 28-31
Fellowships, 29-30
Fields of Study (see Courses)
Financial aid, 29-31

G

Grading system, 21-22
Graduate School of Arts and
 Sciences, 19
 Fields of study, 32-126
 Registration, 4, 21
 Regulations,

H

History, 74
 Courses, 75-81

- Faculty, 74
Program, 74-75
- I**
Interdisciplinary programs, 26-27
- L**
Library, 17-18
Loan program, 30-31
- M**
Map of campus, 2
Marine Science Institute, 18
Mathematics
 Courses, 85-92
 Faculty, 82
 Programs, 82-92
Master's degree
 (see also Courses)
 Admission, 23
 Comprehensive examination, 24
 Language requirement, 24
 Thesis, 24
 Time limitation, 24
 Transfer credit, 24
- N**
NDEA loan program, 31
- P**
Part-time programs
 (see Courses)
Physics, 93
 Courses, 97-100
 Faculty, 83
 Programs, 93-96
- Political Science, 101
 Courses, 102-111
 Faculty, 101
 Program, 101-102
Programs of study, 23-27
 (see Courses)
Psychology, 112
 Courses, 114-116
 Faculty, 112
 Programs, 112-114
- R**
Registration, 21
Regulations
 For doctor's degree, 24-26
 For master's degree, 23-24
 General, 19-23
Research activities, 16
Residence requirement, 21, 29
- S**
Sociology and Anthropology, 117
 Courses, 121-126
 Faculty, 117
 Programs, 117-120
Suburban campus, 18
- T**
Tuition, 28
Trustees, 7
- U**
University Graduate Council, 11-12
- W**
Withdrawals, 22-23

DEPARTMENTAL DIRECTORY

Department	Room	Telephone Number
Biology	403 RI	437-2260
Chemistry	102 HT	437-2822
Economics	301 UR	437-2882
English	170 UR	437-2512
History	358 RI	437-2660
Mathematics	504 UR	437-2450
Physics	109 DA	437-2902
Political Science	340 KV	437-2796
Psychology	440 UR	437-3077
Sociology/Anthropology	580 UR	437-2686

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